VOL·XII NO·5

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

S·A·E

MAY 1923

TRANSPORTATION MEETING NUMBER

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK

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Therefore, to control spring recoil, a brake must be used which is automatically increased as the spring is increasingly compressed. The results produced by such a brake can in no way be even suggested by the decidedly negligible results produced by a brake which is automatically *decreased* as the spring is increasingly compressed.

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YOU PAY FOR THEM ANYWAY—WHY NOT ENJOY THEM

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. XII May, 1923 No. 5

Chronicle and Comment

Part II, 1921 Transactions

MEMBERS who have not already ordered Part II of Vol. 16 of the Transactions covering the last six months of 1921 and who desire copies should send in their orders promptly. This volume will, it is expected, go to press the latter part of the month and the printing order will be based on the number of copies ordered by the members. All members who paid dues for the last half of the fiscal year beginning Oct. 1, 1920, are entitled to a copy of this part of the Transactions without extra charge, but copies will be sent only to those members who send in an order promptly. A blank for this purpose will be found in the advertising section on p. 95.

The Summer Meeting

ONLY a few weeks remain before the opening day of the Summer Meeting of the Society. As already announced, this popular event is scheduled to be held June 19 to 23 at Spring Lake, N. J., on the Atlantic coast. Facilities for meetings, recreation and lodging are excellent at this seashore resort; temperatures are sure to be moderate during the meeting period; it is readily accessible by motor or railroad. Reduced fare privileges have been secured from the railroads in the automotive districts; a special through train will carry the Western contingent to the meeting from Detroit, Chicago, Cleveland, Dayton, Toledo and Indianapolis. Reservation blanks, railroad certificates, rate schedules and all particulars will reach the members with a formal announcement about May 5.

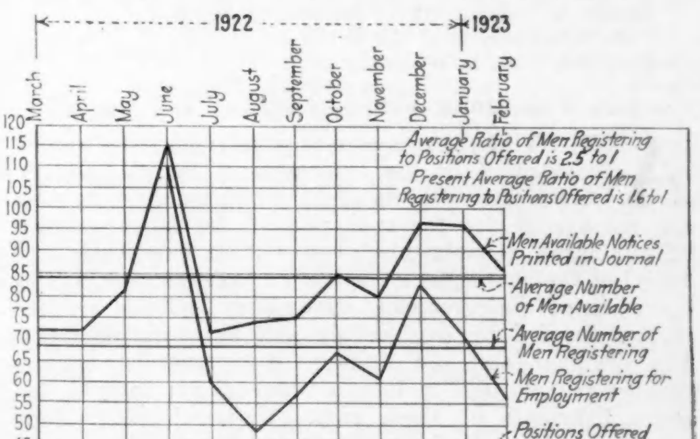
Automotive Transportation

THIS number of THE JOURNAL contains a majority of the papers read at the Transportation Meeting of the Society held in Cleveland last month. An illustrated story of the meeting will be found on page 490. The interest manifested in the papers and discussions at the meeting is clear evidence that we may expect to see more engineering applied to the operation of commercial motor vehicles in the future. Where fleet operation of trucks, motorbuses or taxicabs has been based upon sound engineering principles, the motor vehicle has proved a profitable investment. Slipshod methods whether applied to traffic direction, accounting, maintenance or the selling of transport service, will soon be a thing of the past. Careful study of the papers in this issue gives some indication of what the successful transport engineers are doing; they form the ground work for the accumulation of sound engineering data and experience on the comparatively new science of motor transport engineering.

S. A. E. Employment Service

VERY gratifying results are being obtained by the Society's Employment Service Department through the use of bulletins. The plan has now been in operation for about 1 year. The Society has had listed throughout the year an average of 33 available positions, 41 per cent of which were filled by Society members.

The ratio of men applying for positions to positions offered has averaged, throughout the year, about 2½ men to 1 position, but this ratio has been reduced to



RECORD OF THE S. A. E. EMPLOYMENT SERVICE FOR THE YEAR ENDED MARCH 1, 1923

about 1½ to 1 at the end of February. A marked increase in the number of positions available was noted in January, while at the same time there was a marked decrease in the number of men applying for positions.

The average number of men available throughout the year was 84. Considering that some of these men were holding positions and seeking better connections, and considering the size of the membership, this is a high tribute to the caliber of the men who make up the membership. Employers seeking good men to fill good positions would do well to keep in touch with the Society's Employment Department.

A Market for High-Test Gasoline

THE following data were collected by one of our most active members who was interested in finding out what the average intelligent driver really thinks about good gasoline as indicated by his readiness to pay good money for it. This engineer writes us as follows:

> Last fall one of the large oil companies brought out a fuel that had a specific gravity according to the Baumé scale of from 60 to 62 deg. This fuel was introduced for winter use and we felt it would soon find great favor. On Feb. 1 we began to investigate how well it was introduced among our shop men without any propaganda on our part.
>
> The oil company also markets a winter and summer fuel having a Baumé specific gravity of from 56 to 58 deg. We will call this *B* and the more volatile fuel *A*. We find the following important statistical information which we send to you for we feel that this bears out our contention that the oil companies can profitably and practically market two fuels in the Northern territories where the average temperatures are below 50 deg. fahr. for 6 months in the year.

	Per Cent
Owners in Our Shop Using Fuel *A*	55
Owners in Our Shop Using Fuel *B*	15
Owners in Our Shop Using Other Fuels	30
Owners in Our Shop Using High-Test Fuel	70
Proportion of Ford Cars	51
Ford Cars Using Fuel *A*	53
Average of Cars Used in Winter to Bring Owners to Work	33
Excess of Cars Bringing Owners to Work in the Afternoon Over the Morning	15
Cars Not Used in Winter	6

Contact with Motor-Vehicle Users

A STUDY of the program of papers read at a recent convention of the International Retail Delivery Association reflects great credit on the men who are responsible for the operation of the delivery fleets of our large department-stores. These executives are applying the principles of scientific management to the operation of their vehicles; cut-and-try methods are being superseded by engineering and economic analysis. The designer and the builder of commercial motor-vehicles will do well to turn a watchful eye toward the accomplishments of these men. Unquestionably, they can present ideas to the engineer and the designer.

The following excerpt from a letter received by the Society from the chairman of this convention is interesting:

> After all, the value of automotive engineering can be judged only by the practical daily operations of the men who must maintain the equipment, planned and constructed by the engineers
>
> Our transportation managers and garage superintendents, because of their daily problems in the repair and maintenance of the equipment, find much that they might want to correct in the construction of automobiles, and their advice and suggestions would undoubtedly be of material value to the Society of Automotive Engineers
>
> On the other hand, there are many engineering principles that from an operating standpoint are vital and would be of great benefit in the operation and the maintenance of equipment, if they were presented to our membership from the point of view of the engineer who at the same time has taken the trouble to acquaint himself thoroughly with the problems of the operator
>
> Associations in a given field today cannot work alone and produce the required results. There is a direct relationship among all of them, and better cooperation among such groups will do much to enhance the value of the work of each organization

More was said about this cooperation at the Automotive Transportation Meeting of the Society in Cleveland last month.

Standardization

STANDARDIZATION as applied to manufacturing enterprises may be defined as the reduction of the number of variable factors to a minimum with the object of according to each factor the largest possible share of consideration and capital outlay. In other words, the object is to spread the cost of design, manufacturing facilities and equipment over the greatest possible number of pieces of a given type to reduce the charge on each. A large number of parts can thus be made to carry a heavier charge for better equipment for the purpose of reducing other manufacturing costs, such as time and labor.

It thus becomes apparent that the first matter demanding attention is the nature of and reasons for existing variations in design, with a view to obtaining control of the variable factors. Viewed in this light, many modifications in design and construction appear of the most trivial nature, and certainly should not have sufficient weight to interfere with a general scheme of standardization. Further, in the case of many other changes in design, it will be found that there are no really valid reasons for these at all, the difference being merely due to the fact that designs have originated from various sources.

In the first-named class of differences in design, it is necessary to take a broad view of the whole matter and to consider whether the range of buyers of the product in question is increased or decreased by such departures from a standard. Regarding the second class of differences in design, namely, those which have merely arisen in a haphazard way, as in the case of screw-threads, for instance, the chief difficulty is encountered in the selection of a standard. On this question the preference of the majority is the main guide, and custom becomes the deciding factor.

Another important factor affecting the question of standards is the prevalence of the view that the adoption of standards is a bar to progress. Certainly there are difficulties in the way of making improvements in design go hand-in-hand with standardization, but these difficulties are by no means insuperable. For one thing, a design should not be standardized for production purposes until every measure has been taken to assure that it is the best that can be produced in the light of existing data and practice. Although a standard design is adopted for a period of years, experimental work may still be continued with a view to the standardization of an improved design incorporating the results of research.—*Engineering Production* (London).

Military and Commercial Highway-Transport[1]

By Major Brainerd Taylor[2], U. S. A.

Cleveland Automotive Transportation Meeting Paper *Illustrated with* Drawings

THE paper is a presentation of a practical solution for the coordination of military and commercial transport with rail and water transport. The necessity for combining and coordinating transportation facilities with the idea of organizing a homogeneous transportation network of waterways, railways and highways, proved to be the essence of success in military operations during the World War. The utter inadequacy of pre-war and war-time transport facilities, when organized in separate fields of railroads, maritime shipping and port operations, and the decentralized elements of highway transport, caused the United States Army to make a comprehensive study and plan of the world's war-time transportation with particular attention to the organization of motor transport as the necessary factor in coordinating all transportation facilities. The salient features and general principles of this study and the resultant plan are stated.

The results of this study are applied in an Army plan to coordinate the Nation's network of transportation facilities. The plan is offered by the War Department as a piece of national transportation research influenced by many factors based upon the world's greatest experience in transportation. It contemplates, finally, the establishment in the City of Washington of a National Highway Transport Board or Commission, and of a General Director of Transportation, or a General Traffic Board, to coordinate all transportation facilities.

The principal advantages claimed for this Army plan are the attainment of the full potential capacity of motor transport as a revenue-producing, public-carrier service; the coordination of rail, water and highway transportation so that all three services supplement each other, especially in terminal operations; and a general cooperative action throughout the Nation's commercial, civil and military establishments, to effect the broadest National benefits. It is a general engineering plan leading toward better social and economic conditions and a greatly strengthened national defense.

WORLD WAR MOTOR-TRANSPORT DEVELOPMENT

IN making public Army experiences in transportation and Army recommendations for organizing highway transportation in commerce, the War Department has two interests: First; it is earnestly desired that the Army shall continue to render peace-time service of public value in the industrial life of the Country. Second; the success of all national-defense plans depends very largely upon the capacity and power of our commercial transportation systems, viewed as a national network of coordinated railway, waterway and highway-transport services.

Our greatest national problem in the World War was the "mobilization of man-power and supplies." In this statement "mobilization" must be used in its broadest sense to include all movement throughout the war from points of origin to points of operation. Anything we can gain in normal times toward solving the problem of mobilizing our national resources in time of great disaster will be a big step in preparing for national defense.

The peace-time problem of highway transportation and its relation to railway and waterway transportation has been studied by the Army without any militaristic intention. These studies naturally contemplate the use of highway transport in short hauls of men and supplies to and from railroad stations, steamship docks, camps and Army depots, both in peace-time service and in periods of mobilization. These studies also contemplate questions of public economy, the making, saving or wasting of billions of dollars of private and public moneys due to good or bad transportation practices in our industrial life. The troubles which result from a faulty national system of transportation are of vital import to all citizens of this Country, whether their especial interest be that of capital or labor, of the military or civil, or the one great class to which we all belong, the general public now burdened with increased taxes and a high cost of living.

The first part of this study shows how pre-war transportation, which was developed without any general plan or policy, failed to stand-up under the heavy traffic of war-time movements. It shows how the science of transportation was developed through similar experiences in the different armies of Europe. Those who already know the stories of pre-war and war-time transportation may wish to omit or skip lightly over the first part and give more detailed attention to the second part of this study, which presents a definite, concrete, comprehensive plan for use in solving present and future transportation problems in our own Country.

Pre-War Transportation

Transportation before the war appears to have been developed as follows: Europe, as a result of lessons learned in the Franco-Prussian War, had organized her railroads not only so that they could handle the transportation of commerce but so that they could be operated by their regular civilian personnel, under direction of military authorities in time of war, for the rapid mobilizations and supply that would be required for carrying on military operations. There was also an extensive inland-waterway system in operation on the big rivers and canals of Europe. The British Empire, scattered all over the globe, had forced England to produce her enormous sea power and water transportation. The importance of railroads was not so well appreciated.

Here in the United States, we had built a tremendous mileage of railroad transportation and had produced engines and cars of great tonnage as compared with European railroads. Without doubt, we considered our railroads all that were to be desired from a practical standpoint, and allowed our merchant marine and inland waterways to be nearly starved out of existence. Trac-

[2] Major, Quartermaster Corps, City of Washington.

tion lines flourished in our urban and interurban street-transportation and in European cities, as a very useful hybrid service between railway and highway transportation. Except for passenger cars and the development of roads for touring or military purposes, there was no organized highway transport to speak of anywhere. In Europe, where the value of military highways had long been understood, the roadbeds for highway transportation existed, but no extensively organized highway-transport service had as yet made its appearance.

Speaking of the British people, Col. M. G. Taylor, C.M.G., D.S.O., assistant director of movements, British G. H. Q., is quoted as saying an an address entitled Land Transportation in the Late War[2]:

> The melancholy truth is that in 1914 our ideas of transportation were rudimentary. Our small force of six divisions went to France on their great adventure with no more than a rudimentary organization for transportation. We had an efficient organization for "transport" in the form of road transport, and for sea transport, but we had only a small staff of officers, 31 all told, to insure that our interests were adequately safeguarded in that most important link of all transport services in war, the railways. Coordination between the three, sea, rail and road, was not provided for beyond the provision made in the normal staff organization of the Army, under which the Quartermaster General's branch of the staff is responsible for movement as a whole, and no provision whatever was made for controlling the technical operation of such important points as overseas ports.
>
> What appears now to be a want of foresight cannot be laid to the account of those responsible for directing affairs at the time. The whole of this country was organized, and had been so organized for many years, in separate watertight compartments in regard to transportation. Ports, railways, canals, roads, each undertaking formed an independent organization, the dependency of one upon the others being sufficiently assured by commercial usage. The necessity for any special coordination of the functions of each with those of the others had never arisen because the capabilities of each were equal to the strain imposed by civil movement in peace. It remained for the unprecedented strain imposed by the Great War to bring out clearly that something more was needed if chaos were to be avoided, and that something was the application of the science of transportation. In 1914, military opinion was molded upon civil practice, although the organization put into operation for the movement of our six divisions to France was in effect a fine example of coordinated movement.

This British transportation expert,[2] whom I shall actually quote or follow closely in my thought and in use of phrases during my early remarks on war-time transportation, later says of France:

> It is probable that, in preparing for a future war, France did not have in mind quite so stupendous an affair as that which actually took place, and so for her the ports would not have appeared of so vital a concern as her railways, since most of her supplies would have to be drawn from internal resources. But the point I would like to indicate is that, with all her experience of Continental war, with all the study she had made of probable requirements of modern armies, even France had not realized the need for complete coordination of her transport services, and thus had created a port organization quite independent of her railway control.

In the United States the lack of sea transport, the congestion at our ports and even on our great railway systems is well known. Certain railroads purchased at low prices railroad rolling-stock they did not need, immediately in the early part of the war, while others waited until high prices arrived and then were unable to buy what they needed. Then there was a sudden growth of motor transportation, paralleling some of our biggest railroads, during our own mobilization. These events showed that we had no more general foresight or understanding of how to handle the greatly increased traffic of war than had England and France.

For the allied side, at least, of pre-war transportation, we have the picture of great engineering enterprises, highly developed along lines of rail and water transportation, according to local conditions prevailing in the different countries. Highway transportation as an organized service was non-existent. Specialized transportation, except highway transport, was assuredly developed to a high degree. The science of transportation or logical combination and coordination of the different specialized agencies of transportation, however, does not appear to have been generally understood in any part of the world, unless a study of Germany's transport during mobilization shall reveal a better understanding. For the Allies, the meaning of transportation remained to be developed through evolution in the British, French and American Armies, under the excessive pressure of war-time movements and the forge-like hammering of heavy guns.

War-Time Transportation

It is a well recognized fact that entire nations, not merely armies, fight modern wars. In a war such as we have recently passed through, not only do the resources of a nation have to be mobilized at home but a vast portion has to be further mobilized in international action. Our mobilization during the World War passed over highways, inland waterways and railways at home, then overseas, and finally over railways, inland waterways and highways again in foreign lands. During war, the products of man's industrial work in the fields of agriculture, mines and manufacture, pass through these great processes in movement which he builds up, only to be scattered over other fields, the fields of battle. The channels of these great war-time movements, which we have so lately known, are the same channels through which our future national and international traffic must flow in the more sluggish but ever increasing streams of commerce. One can imagine these channels, in the not distant future, choked again, as in the war, with the great movements required by a reawakened world. Whether that reawakening be for future war or world reconstruction matters not, so far as transportation is concerned. The important thing is to recognize just how our highway transport, for instance, fits in with our national scheme of transportation, and how our national system will operate to advance our interests in world movements.

Visualize in your minds the network of waterways, railways and highways that extended over that part of the world in which the allied nations were active during the war. Inland waterways, roads and highways and the railroads formed interlacing meshes covering extensive areas, while the seaways and many of the long transcontinental railways were like connecting chains, joining up the whole world system.

Again let me quote Colonel Taylor, the assistant director of British movements.[2] In speaking of the war he says:

> I should like to remind you that, while one may consider transportation problems as they arose in any par-

[2] See *Journal of the Royal United Service Institution* (London), November, 1921, p. 699.

> ticular theater, the fact must never be ignored that these problems were, as a rule, merely manifestations of causes which arose at places possibly remote from the theater in question. Transportation in any area is, in other words, merely a link in a chain, or rather a small area in a network, of processes which proceed simultaneously in many widely separated parts of the world. Any disturbing cause in one part of this network is bound to have its repercussion in the particular locality under consideration, and the delicacy of the machinery involved is such that a slight maladjustment in one process may have a considerable and even a disproportionate effect for evil in the supply of an army. Perhaps you may incline to the view that I labor this point unduly, but I cannot help feeling that when it is possible to study the Great War as a whole, and as a matter of history, it will be found that many of our earlier troubles in the struggle were due to an imperfect grasp of this truth. Transportation was the cause of our great difficulties; not fighting power, leadership, or the more active side of military training.

If this commentary is true, and it is certainly corroborated by our own experience, then a nation's best safeguard and most practical method of preparing for national defense lies in the development of her national system of transportation. Rapid mobilization, well regulated supply, quick maneuvers in combat, all most vital factors in warfare, are dependent upon the capacity of the whole network of transportation for making effective coordinated movements rather than upon the number of railroads, ships or trucks which a nation may possess. In commerce, rapid collection and delivery of passengers and freight, regulation of supply and demand, quick movements in relation to collection of peak loads and distribution to markets mean exactly the same things. Transportation is blind as to peace and war. It is a matter of making and coordinating movements regardless of what movements are for.

After the strain of early mobilization and the sudden expansion of the French motor-transport, which resulted in the successful turning movement that stopped the German advance on Paris in 1914, allied transportation, still of a pre-war character, seemed to operate smoothly enough during the long period of stationary warfare which followed the first battle of Ypres. With the Somme offensive, however, in 1916, the weak points in the Allies' transportation showed up. At first there was a lack of trucks at loading points. Next railroad trains had to be strictly limited in number below the capacity of trunk lines, because of lack of engine power, lack of drivers and lack of coal. "Then came a reduction in the capacity of the lines themselves, because the shortage of maintenance labor and material made it impossible to keep them in condition." In short, the railroad service in France began breaking down. One trouble bore heavily upon another with the effect of beating back the movement of the whole system upon itself.

The ports were independent of the railways. The latter failed to clear away the imports, yet imports came in in ever-increasing quantities, in satisfaction of the requirements of the troops in operations, which were planned on a generous scale. Consequently ports, transit sheds, quays and wharves became congested with material of all sorts. Stores could not be moved because they became buried beneath mountains of other stores not yet required forward. Gradually, movement as a whole slowed down, and complete cessation was threatened. As Colonel Taylor says:[4]

> At the same time our Allies became seriously alarmed at the state of affairs developing behind their own armies in a manner exactly similar to what we were experiencing. They were dependent upon imports to a far greater extent than they had originally contemplated, owing to the great excess of demand over the productive capacity of the country made by modern methods of warfare. Consequently, the imminent breakdown of the railways of France was not a local affair threatening one army alone, it was universal, a matter of miscalculation of capacity or of faulty organization. For the French it was the former; for us, as we began to think, the latter.

This state of affairs was followed by the importation from England into France of trucks, engines, railway men and fuel. England also sent over a man of experience and reputation to set British transportation to rights, to connect-up ships, ports, railways and roads, and to put the whole affair on a working basis. This all happened during the battle of the Somme, up to that time the greatest battle ever fought; it happened at a time when the Allies were committed to action and could not back out without the most serious consequences. This British writer[4] laments: "The truth cannot be evaded that it could all have been foreseen and corrective measures taken before the battle, had the science of transportation and its practicable application to war been studied earlier."

Sir Eric Geddes was the man sent over to France by England to solve the new transportation problem. He saw what was wrong and devised the full organization for transportation which was required. He linked-up ports to railways, railways to roads and inland waterways to both. He secured the regulation of sea transport with direct reference to port capacities and to the possibilities of clearance from the ports inland. He developed ports, railways and roads by construction until they could reasonably be expected to carry out the work required of them, and he brought the whole under one unified control responsible for coordination of effort. He showed what *transportation* meant, and how each variation in one process of movement must inevitably have its effect on the others. He finally became Director-General of Transportation, took command of the new organization, got it into running order, and controlled its operation until it found its own feet. With the exception of the German spring offensive in 1918, this was the biggest crisis of the war, and realization of the importance of combining and coordinating sea, rail and highway transportation was, without a doubt, one of its chief and most far-reaching results.

There were many transportation crises between 1916 and the end of the war in 1918, that caused many anxious periods. Many of these we, the United States, shared with our Allies. With the breaking down of the railroads, motor transportation sprang into great prominence. So long as the railroads operated satisfactorily, the motor transport which had been provided and maintained in France was amply sufficient, if it was not called upon to undertake an undue proportion of long-distance work to relieve railways. As a natural result, however, of the railroad breakdown, motor transport, even for really long distances, began to be regard as the most reliable form of overland transport.

The British admit that their motor transport was therefore greatly overworked, and it gradually deteriorated. This deterioration, so far as the vehicles were concerned, was not very marked in the early stages and, in 1916, and early 1917, the course of events was not very obvious, except to the directors of motor transport

[4] See *Journal of the Royal United Service Institution* (London), November, 1921, p. 699.

who were responsible for the provision and upkeep of the vehicles. The result, which *was* clearly obvious, was the effect on the roads due to the heavy use of motor vehicles. The provision of stone for repair became a serious factor of rail transportation. To a certain degree the increased use of road transport, due to the lack of railway facilities, was thus responsible for an increased *use* of the railways; it therefore partially defeated its own object of relieving the railways.

The alarm caused by the deterioration of the vehicles and the roads had its effect in promoting the use of light railways. These saved the wear and tear on both motor trucks and roads. About the time this system of transportation got fairly well going, the Germans demonstrated how easy it was to cut light railway lines with shell fire, and then shoot to pieces the rolling stock and supplies that became stalled. Inasmuch as motor trucks could manage to go around shell holes and keep moving, unless actually hit, motor transportation proved to be much less vulnerable than railway transport. The policy of transportation therefore turned back toward standard-gage railroads, with supplementing road transport, in forward areas. Light railways were to be used as much as possible in unexposed positions, to save wear and tear on roads and motor vehicles.

In 1918 the French railroads had been brought back to life, but British motor transport, in consequence of overuse, was going from bad to worse. Due also to German submarine activities, the gasoline supply was threatened sufficiently to cause added anxiety and need for economy.

In the British Army, as later practised in the American Army, motor vehicles, instead of a motor-transport service, had been furnished to small organizations. These adverse conditions, however, forced the withdrawal of every motor-transport vehicle that could be spared from military units for reconditioning, and their further use after reconditioning in what the British called "general-purpose companies" which were assigned to a "general headquarters, motor-transport reserve," for centralized control. This was the beginning of the development of a British highway-transport service, as opposed to a service organized simply to supply and maintain motor vehicles. The motor truck started off on the wrong foot in all countries following the lead of its elder brother, the so-called "pleasure" car, which is essentially an article of supply furnished to individuals primarily for their pleasure. Effective movements and economy in supply and maintenance ordinarily are secondary matters with such cars, but they are vitally important with trucks and other motor-transport vehicles operating in a public or commercial service. Vehicles of the passenger-car type used in a public service or in commerce are *not* pleasure cars, and the operation of so-called pleasure cars, as such, should never be confused with that of motor or highway transport. They should be termed "passenger cars."

These British general-purpose motor-transport companies were allotted, as in the French army, by G. H. Q. (General Headquarters), to formations which required them, but only for so long as they were actually required. Decentralization and loss of control were not permitted. There is indicated in this British action recognition of a basic principle in highway transportation. Control over the operation of motor transport must be centralized under the same executive authority that dictates the means of maintaining the vehicle equipment at all times in a reliably serviceable condition, with reasonable economy. I shall refer later to a similar, though arrested, movement in our own Army, and again I shall recommend this principle as one of great importance in the development of commercial highway-transportation as an integral factor in general transportation.

Military highway-transportation became a matter of building up a motor-transport service to handle general road movements, under centralized control, rather than a service for supplying and maintaining motor vehicles which were issued to supply and combat organizations for them to operate exclusively in making their own movements.

It is interesting to note that the British entered the 1918 campaign that ended the war on a policy of coordinating sea, rail and highway transportation. Due to forming a general motor-transport service, they made an immediate saving of 4000 motor-truck drivers who were thus released for fighting. They also made rapid progress in reconditioning their deteriorated roads and motor vehicles. The Assistant Director of British Movement, in referring to this policy of coordinating land transportation, says, "Thanks to the policy adopted, we were able to draw the fullest advantage from our road transport."

The French had already a well organized and smoothly running Motor-Transport Service which was centrally controlled and dispatched for general road movements. It was coordinated with railroad movements. In the French Army, the operation of motor transport reached the highest degree of efficiency. The highways which were organized for motor-transport movements of personnel and materiel which were made over them reached enormous proportions. The French railway system and the French highway system were separately organized, but operated as a coordinated whole.

In May, 1918, as a result of the final effort of the German Armies to capture Paris, French railroads were again so disorganized as to be rapidly approaching a state in which they could be disregarded as a factor in the military situation for large movements. It was only the work of the road-transport service which enabled the allied force to be maintained. Had the policy of supplying motor vehicles to field units not changed in the French and British Armies to a policy of supplying organized highway transportation, the German spring offensive would have encountered the same weakness of movement behind the allied lines that existed during the allied Somme offensive. Being on the offensive, however, in 1918 she must surely have felt any such great weakness in transportation as that of 1916, and pressed the harder for a final decision. Highly organized highway transport in the French and British Armies was the principal agency of movement that enabled the Allies to stop the German drive in 1918, just as the crudely organized motor transport in the French Army enabled the Allies to stop a similar German drive in 1914. The repeated imminence of world disaster, due to faulty transportation policies, in 1914, 1916 and 1918, is only too apparent.

It would be useless to review war-time transportation with the idea of using its lessons profitably in any post-war reorganization or establishment of national policies, without facing our errors with honesty and boldness. Every foreign government knows that, in 1916, the United States was disgracefully unprepared for even any effective defense in its homeland against the attack of any first-class power. It also knows that, in spite of this unpreparedness, with French and British help and protection, the United States mobilized its resources and arrived in France with sufficient dispatch and force to

turn the rising tide of defeat away from her Allies. With the exception of our national unpreparedness we have proud records as a Nation, as an Army, as minor organizations and as individuals. At home and overseas, we bent our energies together to win the war. With such facts behind us, it seems to me that we can and should focus the light of research upon our errors. The groups or individuals who were personally responsible for errors have unusual opportunity to render constructive services of unlimited value by admission and discussion.

In the spring of 1918, we in the American Army were supplying vehicles to all forward units in very much larger numbers and truck-ton capacity than the French and British had done. Notwithstanding this, we were also receiving assistance from the organized highway-transport service of the French to move our troops and their supplies in battle maneuvers. Although our vehicles were all practically new, rapid deterioration began to cause serious anxiety. Every small organization in the field, equipped with motor vehicles, began tearing down its disabled vehicles to make its own repairs. Repair parks with field units were littered with dismantled vehicles. There was no systematic connection between these combat and supply organizations and the motor-transport service organized and equipped for general repair. Out of every two or three motor vehicles requiring general repair, they would tear down all and then rebuild one, scrapping what was left; this, mind you, in the first year of service of brand-new vehicles. It was justified, they thought, by the exigencies of military service.

To maintain their own small fleets in readiness for field movements they knew would come, each small combat organization and decentralized truck-train started in to rob disabled vehicles, wherever they were found, of the spare parts of which they could be dismantled. These parts, with the supplies they requisitioned from automotive depots before they were needed, they hoarded against the day when their own vehicles would need repair. Every truck driver in the Army became a collector and a road vulture so far as disabled trucks were concerned. Small-fleet operators cannot be blamed for these uneconomical practices. They were incident to a system of decentralized trucking.

The Motor-Transport Service, organized only for automotive supply and repair, was bitterly assailed for not having the spare parts required by hard-pressed forward units under these conditions. The Motor-Transport Service gave up all the supplies it had, required by such units, and then was unable to make the repairs for which it was responsible when the dismantled and stripped vehicles finally drifted back to repair parks.

The weakness of decentralized control in motor transportation was not lost upon General Pershing and his staff. After our St. Mihiel drive, and during the Argonne, in October and November, 1918, General Staff officers from our own G. H. Q. were working in the First and Second Armies, drawing out about 60 per cent of all divisional motor-vehicle equipment to form a general-service motor-transport reserve to be placed under the control of Army commanders. This would have been similar to reforms in motor transportation undertaken earlier in 1918 by the British, and already effective with the French. With the signing of the Armistice and cessation of pressing need, this movement was abandoned, before our fighting troops and supply services could experience the same benefits from the change the French and British had experienced. I have always looked upon this arrested centralization as a great misfortune, the loss of a wonderful opportunity for our Country to experience the power and capacity of an organized Motor-Transport Service as against the use of small fleets and single vehicles. We did make the change from the decentralized operation of motor vehicles to the centralized system exactly as the French and British had done, in the American Service of Supply.

Without knowing at the time that we were going through the same phases of motor-transport development that the French and British had gone through, we made our changes to meet the requirements of new emergencies as they arose, when old methods failed. Perhaps the personal touch of my own observations and experiences in the Advance Section, A. E. F., may serve to bring out the fact that we Americans were having the same experience as our Allies in the evolution of transportation that was going on everywhere during the war.

Early in January, 1918, I was appointed Chief Motor-Transport Officer for this Advance Section, from which point of vantage I had a wonderful opportunity to observe the operation of motor transportation; first in the Supply Services, A. E. F., and in the separate Divisions as they arrived, then in the First and Second Armies from their formation after Chateau Thierry to the Armistice, and finally in the Third Army during its advance, without railroad service, to Coblenz on the Rhine. I also observed part of the French Motor-Transport Service and caught glimpses now and then of some of the British and German motor transport. With all this transportation operating about me, I was busy organizing the American Motor-Transport Service in the Advance Section. Indeed, most of the vehicles issued to the armies in our front, and all the automotive supplies, were received from the base and intermediate section and distributed from Advance Section parks and depots. In addition to supplying combat and supply units with the vehicles and the spare parts they required, we were establishing the advance automotive-supply depots and repair shops to make the major and general repairs that would be required by about 100,000 motor vehicles operating in the forward zones.

In the Motor-Transport Service which I personally commanded, there were, roughly, 10,000 officers and men, many of them highly experienced in one phase or another of the automotive industry. We coordinated my knowledge of the Army, and that of the three or four regular officers who served with us from time to time, with their combined knowledge of the industry, to build up our service to meet the motor-transport requirements of the war as it developed in our vicinity. While these temporary officers and soldiers were learning to look at motor transportation from a military point of view, they were teaching the regular Army the details of motor-truck operation and repair. Together, we learned about the science of transportation or the science of movements. The military mission in which we were using this science was a temporary situation, an incident in the history of transportation.

The weakness of decentralized motor-transport organization in a crisis is illustrated by the following incident in our Advance-Section experience: The general order issued from G. H. Q. in December, 1917, which created and described the Motor-Transport Service in the A. E. F., distinctly states that a Motor-Transport officer is *not* responsible for the operation of motor vehicles after they are issued to units and other services. Certainly the chiefs of other services took this view. During a serious

emergency, when it was perfectly apparent that some one Motor-Transport officer had to act to direct road movements over the entire Advance Section, I was forced to assume this responsibility over all motor vehicles in the section. Although not recognized by official orders, this action was, nevertheless, generally recognized as the correct solution of the particular problem in transportation presented by the emergency.

On May 30, 1918, during the height of the German drive toward Paris, our American G. H. Q., with considerable evidence of anxiety, directed me, as the Advance Section Commander's Motor-Transport Officer, to make certain road movements involving the use of several hundred motor trucks. Having very few trucks left under me, as a result of the above quoted order, and realizing that the order carried with it the expectation that I would meet and overcome whatever obstacles were in the way of its execution, I assumed command over all motor vehicles in the section, regardless of what other services they might belong to, and sent out telegrams, dispatch riders and officers on motorcycles to gain actual control. About 300 vehicles were dispatched to threatened points within a few hours and as many more mobilized for further orders from G. H. Q.

On May 31, the Commanding General issued orders that, except in a few instances where the vital importance of a local activity made it inadvisable to ride roughshod over its commander's objections to giving up his fleet, all motor vehicles would be turned over to the Motor-Transport Officer for operation. In accordance with this order, vehicles and small fleets were actually pooled for general transportation at motor-transport centers established with relation to rail-heads, railway stops, camps, depots and other activities, and the control over motor transportation and maintenance of vehicles was centralized in my office.

As the effectiveness of this centralized motor-transport service became more and more apparent, even the exempted vehicles and fleets were turned over to us by the voluntary action of their local commanders, with only one noticeable exception, which no doubt would have followed had the war continued. The combined fleet, which was finally maintained and operated from these centers under my general direction, numbered about 3500 vehicles of all kinds. In the St. Mihiel and Argonne offensives, this fleet not only carried on the increased highway-transport service caused by these drives, without help from outside sources, but it gave up to the combat divisions about 15 per cent of its vehicle equipment and many of its officers and men. Increased effectiveness and economy in motor vehicles and maintenance of vehicles were very apparent after centralization.

This incident showed officers at G. H. Q. that they could not expect action in road transportation if they had to wait for orders of movement to be given to from 30 to 40 or more scattered fleet operators. It showed the Commanding General of the Advance Section that he could not meet his responsibilities for making quick or effective road movements unless he centralized control over his motor vehicles in a single office, vested with authority and equipped with communications to carry out his orders of movement. It showed us in the Motor-Transport Service that unless we hooked up the function of operating vehicles with the function of maintaining them in a systematic manner, there would be, in a comparatively short time, no movements whatever to speak of, with the rapidly deteriorating trucks and cars with which we stumbled through that emergency. It showed us that anything but a well balanced, centrally controlled Motor-Transport Service is dreadfully wasteful and extravagant, and that decentralized trucking will always be ruinous to many private operators and extremely dangerous to any important enterprise which relies upon it.

Experiences similar to these, but perhaps less emphasized, are being encountered in commercial transportation at present. We progress in circles; war transport follows commercial transport which, in turn, follows war transport again. It is a vicious circle when we pass on bad practices or fail to translate the teachings of one experience to the next. On the other hand, brilliant success in the movements of war and commerce should follow a nation's intelligent appreciation and application of the science of transportation which it develops in its combined experiences.

See how closely we followed our pre-war commercial experience in the use of motor vehicles. During the period from January to May, 1918, every officer of importance and prominence and many an officer who was not prominent at all, except for his continual joy-riding presence on the highway in a high-powered car, thought he had to operate or control his own motor car. This idea, that each officer must have his own car, is directly traceable to our "pleasure-car" experience at home. The idea that each individual citizen of this Country should own and operate his own automobile is the secret of the wonderful rise of our automotive industry. It is the reason for the fact that, in a world registration of cars and trucks,[5] more than 12,364,000 of the world's 14,750,000 motor vehicles are in the United States. Of these 12,364,000 motor vehicles, more than 11,000,000 are motor cars and motorcycles. In the use of motor cars, individual pleasure, personal comfort and satisfaction are the primary considerations, even when business and business efficiency are claimed as the real reasons for obtaining a motor car. Effective transportation with economy in vehicle operation and upkeep is a secondary matter, in the case of passenger-car types used by individuals. This is so in civil life; so it was in the Army, among regular and temporary officers alike.

Again note the influence of pre-war commercial practice on military transport. Every small organization in our Army was issued animal-drawn and motor-drawn vehicles according to the weight and cubic measurement of its impedimenta, and the ammunition, food and other supplies required for its independent road movements and action for a given number of days. These vehicles were controlled solely by immediate commanders who had no power to control general traffic, except to gum it up, and no practical knowledge or means of keeping their vehicles in a constant state of mechanical efficiency, with economy in use and repair. This was absolutely the replica of commercial practice in the trucking game. Here in the United States, the 1,364,000 or more trucks which have been built so far are held in comparatively small fleets by companies that cannot afford to combine in their private trucking services adequate means for complete maintenance, which alone is capable of reducing the costs of vehicle operations and upkeep to its most effective and most economical basis.

The number of small, private fleet-owners who have operated trucks without realizing potential profits, and even at a loss, is better known in the automobile industry than anywhere else. There have been some interesting data furnished on this subject by the Curtis Publishing Co. and other sources. Accurate cost accounting

[5] See *Automotive Industries*, Feb. 22, 1923, p. 366.

in trucking has not been practised much more in commerce than it was in the Army during the war. Very few companies, I venture to say, know exactly how their operating and maintenance costs compare with what their vehicle equipment should cost to operate and maintain, or whether revenues realized with new vehicles will continue as the vehicles deteriorate. There is no possible way to obtain comprehensive and reliable cost accounts from a decentralized system of trucking. As to the exercise of highway-traffic control and the coordination of highway-transport movements with rail and water movements in accordance with a regulated supply and demand, no such thing was practised in commercial trucking and therefore none was practised in the Army. The problem of highway-traffic control is bound, in the near future, to become fully as interesting and urgent in commerce as it was in the hectic movements of war; that is, if the production of passenger cars and the construction of highways are any indication of what the next 5 years will bring forth in the way of cargo-carrying trucks and tractors.

In dealing with the growing use of motor trucks in American commerce and their relation to the railways, in which the Country has vital interests of a financial and a practical nature, transportation engineers are face to face with the same questions that were faced in wartime transportation. Some of them are the same engineers who wrote into our military laws the conception and vision which in 1917 and 1918, only about 5 years ago, they had concerning motor transportation. It will be very interesting to see whether their vision and understanding concerning motor transportation have developed at all since then, and how they have developed. In December, 1917, one of our pioneer motor-transport officers submitted to G. H. Q. a draft of the order that created the Motor-Transport Service. An engineer on the General Staff, who now holds an important position as a consulting engineer in general commercial transportation, revised and edited this draft and wrote into the order the following vision of motor transportation. His conception became military law when signed by the Chief of Staff, who needs must rely upon the judgment of his engineers in such matters. The order states

> The Motor-Transport Service has no responsibility in connection with the *operation* of authorized M. T. S. vehicles and units after their assignment by competent orders to units or to other services. All movements of transport so assigned are controlled directly by appropriate commanders. . . . The principles enunciated in (*f*) (this refers to sentences just read), are further emphasized by the following simile: An authorized automobile or automobile unit, after assignment to an organization, is exactly on the basis of a horse, mule or field train assigned to a regiment, and therefore the authority of the M. T. S. over the vehicle or unit so attached does not exceed the corresponding authority of the remount or other service over the animals, vehicles and transport units similarly assigned.

This idea that an automobile took the place of an officer's charger and that a truck took the place of the old Army mule is stamped indelibly upon the minds of many Army officers. It also prevails outside of the Army, where the family phaeton and "Old Dobbin" have given place to phaeton and sedan motor cars. The rich man's coach is replaced by his limousine. Every conceivable kind of a mule or horse-drawn cart or wagon has been replaced by a similar motor-driven vehicle under the same kind of decentralized ownership as in the case of its animal-drawn predecessor.

Individually operated vehicles and small fleets can never give an effective and economical highway-transport service in commerce, any more than they did in the war. Already they are combining into larger services. Witness the taxicab companies, the American Railway Express Co., and others. These are steps in the right direction, but we need to speed up the process. Transportation requires larger trucking companies in closer combination with railways and waterways.

Shortly after the issue of the December, 1917, order, which damned the motor truck as a muleish thing and the Motor-Transport Service as nothing more than a hospital service for trucks, the author of that limited idea moved out of the sphere of direct influence on military motor transportation. An order was then issued from G. H. Q. which created the Motor-Transport Corps in the A. E. F. This order showed greater vision and a growing understanding in that it gave this specialized corps, equipped to operate motor vehicles, operating control over some of the motor vehicles in the A. E. F. It provided for the organization of motor-transport units for general trucking purposes. The majority of motor vehicles were issued to other services, however, and therefore exempted from being included in the organization of a Motor-Transport Service.

Although the order of May, 1918, was a great step forward over the order of December, 1917, the substitute of a truck for a mule idea which had been given the Army interfered with all subsequent efforts to centralize and coordinate motor transportation. Even under the May order, no one authority could be held responsible for conducting satisfactory road movements. Always, although we had more trucks than the French, we had to have help from them in moving our troops in battle. We were not experiencing a saving of 4000 truck drivers and "drawing the fullest advantage from our road transport" which followed the British centralization of control over motor trucks.

Highway-traffic control, at this period, was looked upon as a matter of giving orders to combat and supply organizations to make road movements, and then of giving further orders to military police to stand at the crossroads like traffic officers in America to keep the vehicles moving. The railroad idea of traffic control, with its comprehensive inclusion of coordinated movements of passengers and freight, made by an operating service and supported by organized maintenance of way and equipment, came very slowly. The still more advanced idea of general traffic control, that is, controlling and coordinating the required movements of passenger traffic and freight traffic through terminals and ports, over railways, waterways and highways, each service made up of its own specialized branches of Operation and of Maintenance, was not to be expected until the threat of impending disaster to most important missions became a compelling factor in the general situation. It would require a very large book to hold all there is to tell about the evils of decentralized motor transportation, and of failure to realize the necessity of coordination and continuity of movements throughout the network of general transportation.

As an example of the result of broken continuity in general transportation, I will refer to the report of E. A. Halblieb and J. W. Tracey, who were sent to Europe by Dodge Bros. in the fall of 1918. Dodge cars were facing a general breakdown, although the Dodge company had supplied all the spare parts requisitioned. We had mountains of Dodge parts in the Advance Section, but certain vital parts, required in extraordinary quantities as a result of the unforeseen and excessive demands of the

decentralized trucking system in the armies, were not in France. Other makes of vehicle were also approaching a general breakdown and need of overhaul. With a breakdown in our motor transport, unless French and British transport could have been substituted, the American offensive, then rolling back the Hindenburg line, would have been halted. Forward units could not have advanced, rail-heads and dumps could not have been cleared, rail trunk-lines and ports would have been hopelessly congested, rail movements at home and overseas shipments, expanded to support our offensive campaign, would have further flooded the already congested ports. The whole general system of overseas movements was threatened by the spare-parts situation in motor transportation.

Had the war and our decentralized system of trucking continued a few weeks longer, we would, I am confident, have encountered this very serious situation. It would have been similar to the British experience during the Somme offensive in 1916, and the work of coordinating our overseas movements, the greatest transportation undertaking the world has ever seen, would have been harder and would have taken longer than it did with the British, because of the greater distances and difficulties of communication. The British transportation expert, whom I quoted earlier in my paper[6] might have been writing of the American transportation situation when he said:

> While one may consider transportation problems as they arose in any particular theater, the fact must never be ignored that these problems were, as a rule, merely manifestations of causes which arose at places possibly remote from the theater in question. Transportation in any area is, in other words, merely a link in a chain, or rather a small area in a network, of processes which proceed simultaneously in many widely separated parts of the world. Any disturbing cause in one part of this network is bound to have its repercussion in the particular locality under consideration, and the delicacy of the machinery involved is such that a slight maladjustment in one process may have a considerable and even a disproportionate effect for evil in the supply of an army.

In looking toward the future of motor trucking and in adopting a national policy of transportation, this established truth should not be overlooked. It is not only essential to preserve this broad vision of world transportation in formulating national policies, it is also necessary for the automobile industry, the railroads and the truckers to build in harmony with it, if they wish to build on solid foundations that will withstand the strains of increased movements due to war or national expansion.

Post-War Transportation

I have barely touched upon pre-war transportation, but enough to show that it was one of uneven and uncoordinated development of specialized services. Sea transport dominated in Great Britain, railroad transport dominated in Europe and the United States. Canal and river transport flourished in Europe until interrupted by the war. Highway transport was everywhere a matter of supplying and operating individual vehicles, or small independent fleets.

I have shown more at length the evolution of transportation throughout the war, the similar experiences of the French, British and American Armies with regard to motor transportation and its development as an organized service for general purposes. I have indicated the development of coordinated waterway, railway and highway transportation as a result of war-time traffic, with its probable effect upon the world's history in the part it played during the Somme offensive and the drives of 1918.

We have done with war, so far as this generation is concerned, I hope. So far as future wars are concerned, our armies will enter them with whatever transportation practices are general in commerce at the time. We cannot afford to create a national transportation system for war alone. Ideas of special preparedness measures in transportation, contrary to commercial interests, are entirely impractical. As the history of transportation is reviewed 50 to 100 years from now by students who are interested in its development, the influences of the World War will be seen more clearly than they are at present. We are still too near the war for every one to gain a clear perspective easily. Those who know have not yet completed writing the full, comprehensive accounts that will make up the history of the world's war-time transportation. This much can be said, however, as it has happened in every other great human activity, as it happened in Europe after the Franco-Prussian War in regard to railroad transportation; the war will influence post-war development of transportation in direct proportion to the intensity of suffering or of success which attended war-time experience. England will not forget the Somme. France knows the importance of organized highway transport, as it undoubtedly saved Paris in 1914 and 1918. Germany will remember that when her advanced armies were almost in sight of Paris they could not go on, or even hold their ground, because the extended German transportation system failed to move up the required supplies.

The United States, saved from suffering any reverses or extreme anxiety by an armistice that was signed within 6 months after serious American fighting began, is more apt to miss the significance of the war's great teachings. Already we have shown that we do not consider it necessary to control the overseas transportation of our imports and exports. The relation which a sea transport, when coordinated with our railways and highways, might bear toward regulating the overproduction on our farms with the starvation which has been rampant in foreign countries, has not been understood. Perhaps those millions who starve could not have paid for our supplies and transportation. Certainly those who die can never trade with us in the future. Perhaps it is just as well for us to let the sea and foreign markets take care of themselves until we have solved the problem of our continental transportation. Here we have live questions of overland and inland-waterway transport to settle. Shall they continue as separate, independent establishments competing with each other, destroying valuable public investments of yesterday to enhance the value of new investments of today, or shall tomorrow's investments be combined and coordinated with those of today and yesterday to save our capital, produce new earning power and build for us a system of freer movements that shall effect greater savings and profits for carriers and shippers, for labor and capital, for the entire population of our Country?

I certainly believe that all this can be done, not by killing competition, not necessarily by Government ownership, but by private enterprises that are joined to effect powerful combinations in rail, water and highway transport.

The experiences of war which I have recounted to you and recent happenings in regard to commercial transportation give ample evidence as to how these bene-

[6] See *Journal of the Royal United Service Institution* (London), November, 1921, p. 699.

fits may come to us. On Jan. 27, 1923, a distinguished group of transportation executives met in New York City at the call of Julius H. Barnes, president of the Chamber of Commerce of the United States. The Secretary of Commerce, Herbert Hoover, was present. The resolutions drawn up at this meeting have been published[7] and are familiar to all transportation men. They provide for a comprehensive study of the whole question of national transportation with a view to formulating a "coordinated national-transportation policy."

Our cabinet ministers have been discussing national transportation. At a recent meeting, I am informed, the subject of our coast-to-coast traffic came up for consideration. Government figures indicate that, if the traffic which passes through the Panama Canal continues to increase at the present rate, the capacity of the canal will be reached in a comparatively few years. The question of enlarging the Panama Canal or of establishing a new and shorter route by digging the Nicaraguan Canal arises, the idea being to relieve congestion on the transcontinental railroads. This is another long link in our national network of transportation which must be coordinated with railway and highway transportation.

On Dec. 7, 1922, President Harding, in his message to Congress said:

> Manifestly, we have need to begin on plans to coordinate all transportation facilities. We should more effectively connect-up our rail lines with our carriers by sea. We ought to reap some benefit from the hundreds of millions expended on inland waterways, proving our capacity to utilize as well as expend. We ought to turn the motor truck into a railway feeder and distributor instead of a destroying competitor. . . . Costly highways ought to be made to serve as feeders rather than competitors of the railroads, and the motor truck should become a coordinate factor in our great distributing system.

The Army has been working along these lines for several years and already has such a plan which it is ready to present as a peace-time industrial-service and a step forward in national defense.

THE ARMY PLAN OF HIGHWAY TRANSPORT

National plans for coordinating transportation facilities in the United States and for developing highway transport in commerce as the coordinating factor, should be based on the best and broadest practices developed during the unusually heavy traffic strains of war. The motor-transport organization in the Service of Supply in France forms a very definite background for the study and planning of highway-transport organization in the United States. Some idea of the plan of the centralized Motor-Transport Service in the S. O. S. in France can be gained from a map, which is reproduced in Fig. 1, showing the motor-transport repair-activities in the Service of Supply, A. E. F., as they existed on Nov. 11, 1918.

The resemblance of this motor-transport maintenance organization in the Service of Supply, A. E. F., to the plan of a National Motor-Transport Service in the United States is striking. See Fig. 2. The concentration of population and motor vehicles and the close network of improved highways and motor-transport centers in the northeastern portion of both maps make the two problems appear much alike.

The Army plan for organizing a National Highway-Transport Service in this Country and for coordinating it with Railway and Waterway Transportation has been developed in several recent studies which have been incorporated into a base plan for the United States. This plan of a nation-wide motor-transport service might be developed privately in commerce or publicly for war or other emergency, wherein the objects sought are freedom of movement in general transportation with the greatest effectiveness and economy of effort and capital invested.

This is not an academic study for war or other emergency. It is true that it will serve in such events as a basic plan, from which to construct operating plans to fit the general circumstances and special requirements of whatever emergency may arise. The primary purpose of this presentation is purely for the benefit of commerce and public economy. The benefits of this plan, which will first be felt among the truckers in making operation and maintenance financially safer and more lucrative, will, I confidently believe, quickly spread to railway and waterway carriers, and thereby, with multiplying effect to transportation capital, transportation labor, the shipping and traveling public and finally the Country generally. This plan suggests organization of highway transport as the coordinating factor in general transportation. Its details are not complete, but its principles have been sufficiently tested to prove their value as a foundation upon which to build.

This plan will serve as a basis upon which trucking companies can combine in any city, state or group of

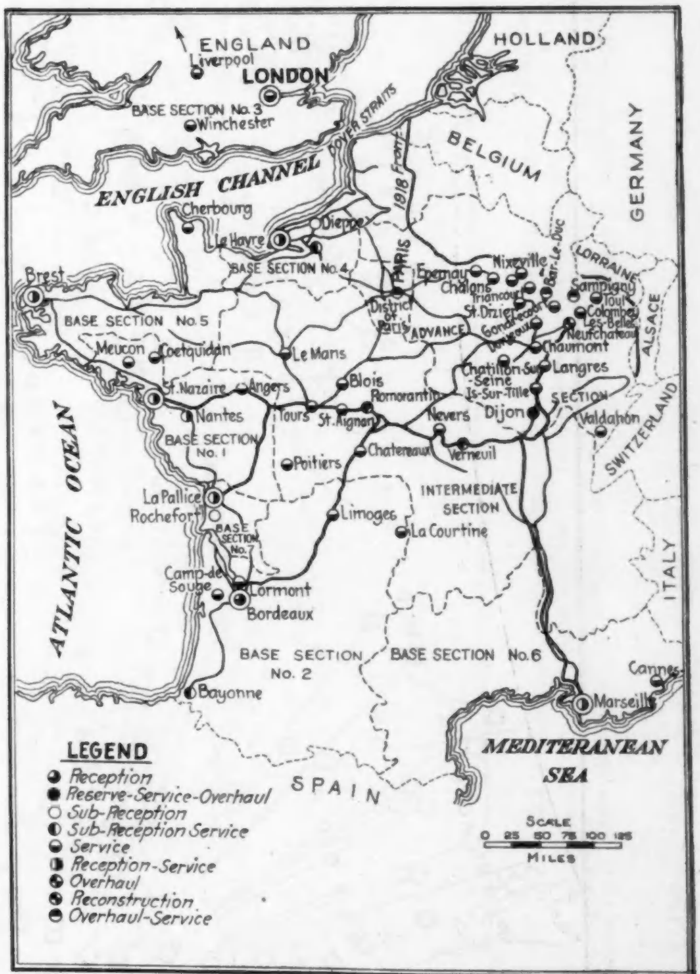


FIG. 1—LOCATION OF MOTOR TRANSPORT CORPS REPAIR ACTIVITIES IN THE SERVICE OF SUPPLY, A. E. F., AS THEY EXISTED NOV. 11, 1918

These Activities Embraced All Automotive Repairs for the Entire A. E. F., except Minor Repairs of Vehicles Made by the Combat Divisions in Battle Areas. Rail-Heads and Motor-Transport Centers, in Other Words Traffic Centers, Were in the General Vicinity of These Repair Activities

[7] See *Automotive Industries*, March 8, 1923, p. 578.

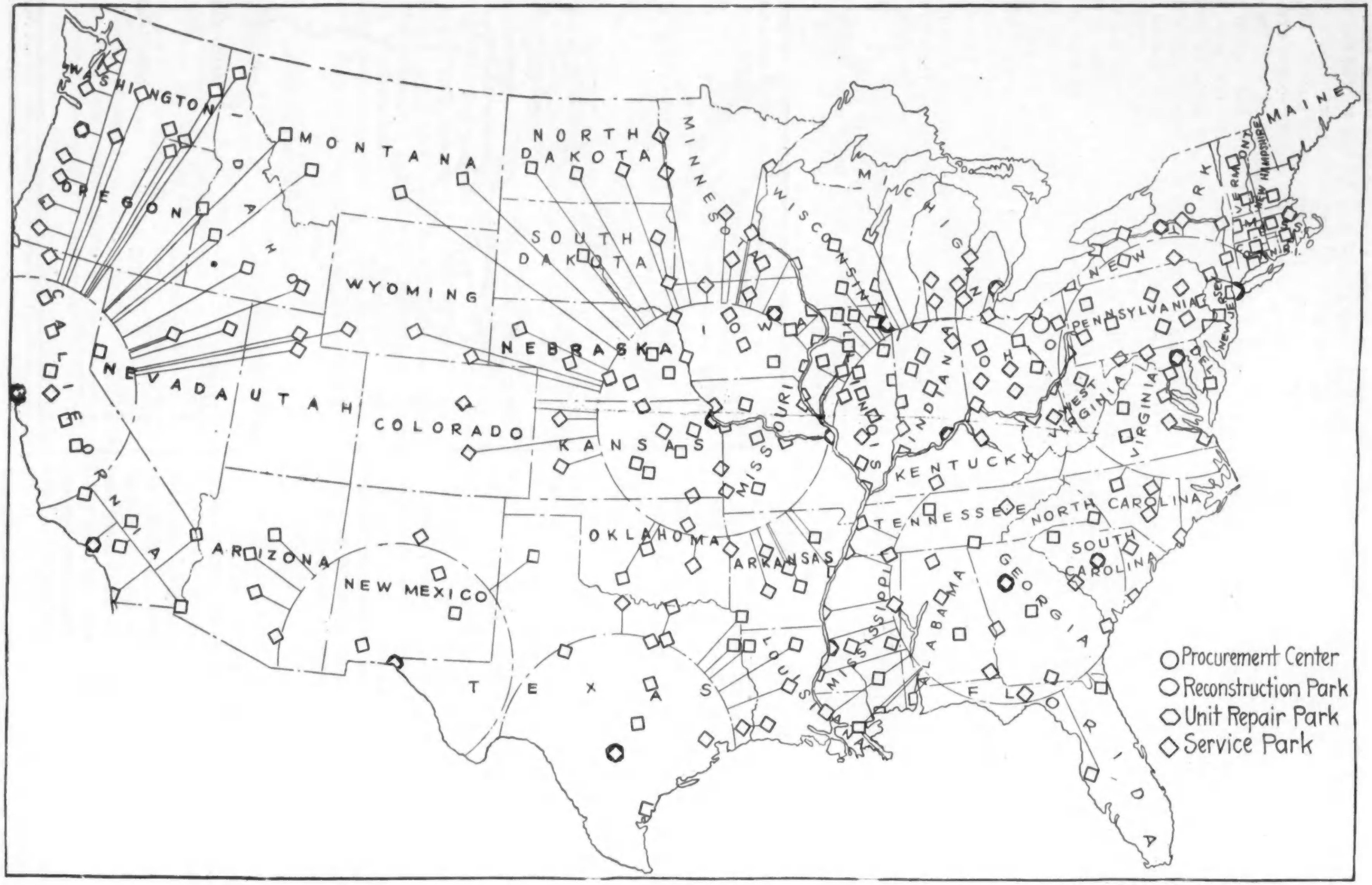


FIG. 2—AUTOMOTIVE MAINTENANCE ACTIVITIES REQUIRED TO SUPPORT A NATIONAL MOTOR-TRANSPORT SERVICE

The Maximum Economy in Vehicle Maintenance and Plant Operations Are Gained through the Centralization of Procurement, Major Repairs and Control over All Maintenance Functions at What May Be Termed Central Powerplants in Highway Transportation Indicated by the Centers of the Very Large Circles

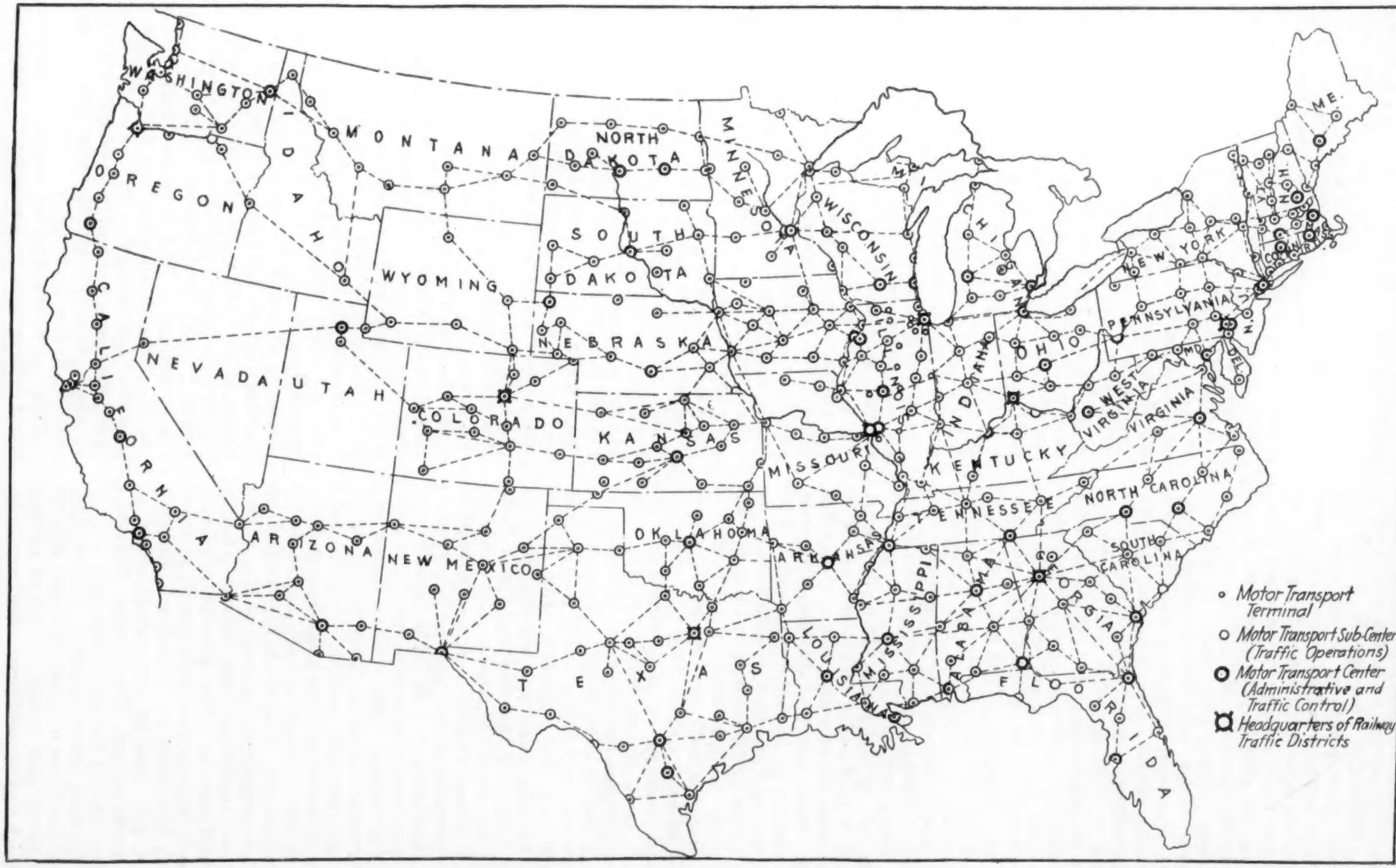


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FIG. 3—GENERAL TRAFFIC CENTERS AND HIGHWAY TRANSPORT CENTERS COMBINED INTO A NATIONAL PLAN OF COORDINATED TRANSPORTATION

In This Plan Terminal and Port Facilities Are To Be Developed at General Traffic Centers To Coordinate Railway, Waterway and Highway Transportation. Highway Transportation Is To Be Organized around the Highway Transport Centers and Operated as the Coordinating Factor in General Transportation. The General Principle of Making Long Hauls by Railway or Waterway and the Short Hauls, Such as the Collection and Distribution of Less-Than-Carload Freight and Door-to-Door Services, by Highway Transport Is Followed

states in the larger organization of highway transportation, found in war-time service to be the only kind of motor-transport organization that would permit the realization of very great economies in operation and maintenance. These larger organizations produce more effective and therefore more profitable traffic operations. They permit a reduction in vehicles in congested streets without restricting the general production and sale of vehicles throughout the Country. Many of the congested traffic problems, now puzzling city engineers, will automatically disappear under good centralization in organizing highway transport. The plan will serve as a basis for combining railway, waterway and highway-transportation companies, for the realization of even greater economies in joint operation and maintenance than are possible in separate operation and maintenance. The plan is particularly applicable and interesting in the study of national-transportation policies which are being contemplated with a view to coordinating all transportation facilities. Lines of thought and effort in all the different activities that go to make up our national scheme of supply and transportation can be given a general direction and coordination by the adoption of a basic plan like this in private enterprise, industrial commerce or public emergency.

On the map of a "National Motor-Transport-Service," shown in Figs. 3 and 4, traffic centers are indicated by small circles drawn with a radius of 10 miles, as per map scale. These have been established by many Army engineers working in the field on this study. They are tentative centers only and may be abandoned or replaced by others as the study proceeds or changes. The principles which apply to the selection of traffic centers are as follows: Highway-traffic centers should coincide with railway and waterway-traffic centers to make possible the practical coordination of terminal and line operations, in all three transportation systems. The general-traffic centers thus formed should be reduced to a minimum and located so as to permit the reduction of terminal operations and overhead costs, with the maximum control over traffic in all three systems, using rail and water transport for long hauls and highway transport for collection and delivery and for short and broken hauls.

The following important requirements are fulfilled in the National Highway Transport Service planned by the Army in its proposed general plan for coordinating our national transportation facilities. The principal railway systems of the United States pass through and connect the principal general-traffic centers tentatively selected. The principal Coast and Lake ports coincide with important general-traffic centers. The navigable rivers and canals, shown in our river and harbor projects, also pass through the principal centers located in the vicinity of such waterways. Most of the highways shown in our federal-highway project, a project of the greatest national interest and importance, pass through the principal general-traffic centers. The principal highways already in existence, improved and unimproved, as shown by the Automobile Blue Book and American Automobile Association maps, pass through and connect almost all of these general traffic centers. The principal Blue Book routes are the ones used in this particular study.

The majority of these general-traffic centers, as they now stand, occupy positions of great strategic value in our national commerce, and in any scheme of national transportation which may be considered. Highway transport organizations established at these points will be able to participate in, if not control, most of the highway movements of the Country. They are in close proximity to the great markets and storage centers, and within easy trucking distances of all the collecting and delivery points in the fields of our principal industries; agriculture, transportation, manufacturing and mining.

If any serious disaster ever threatened this Country, an emergency transportation system could be organized quickly on these points with absolute certainty of establishing a basic network upon which to hold our Nation together, with sufficient means of movement to assure our people of a regular supply of food, fuel and other necessaries of life. If commercial war between railroad transportation and highway transportation should unhappily result from a failure to find and adopt a general plan for coordination and cooperation in overland transportation, these or similar points, because of their relation to the general traffic of the Country, will prove to be commanding points in the contest. Until other centers are added or substituted, these will serve for further study.

If the science of transportation is the same in commerce and war, and success in applying such a science depends upon the superiority with which the factors that enter into transportation are combined and operated, we can dismiss the thought that this plan smacks of war and emergency and confine our thoughts solely to commercial requirements, content that it has been proved in war and will work for the public good in emergencies. We will turn our thoughts toward solving the transportation problem for expanding traffic, future railroad-blocks and congestion due thereto, unsatisfactory financial conditions, riddles in truck and highway development and the troublesome question: "How will motor transport affect the railroads?" The details of just how this or any other national plan of transportation will be developed in commerce must be left to commerce. The Army can simply outline general procedure of a cooperative nature.

To demonstrate this study fully, it will be necessary to assume certain steps and actions. Assume that the Pennsylvania Railroad and other large railroad systems called meetings of the leading truckers along their lines to consider ways and means of developing a highway transport, to operate from traffic centers, mutually established at strategic points, in a service of highway collection and distribution, primarily, with regard to railroads, and assume that they all used this Army plan as a basis upon which to work up their resolutions. It would not matter vitally whether the railroads established ownership over the highway-transport organizations which might be formed at these traffic centers, or simply agreed to do business with them if they combined and subscribed to contracts which would establish a means of coordination and avoid unscientific competition and consequent economic waste.

Assume, if you will, that the Society of Automotive Engineers or the Chamber of Commerce of the United States called such a meeting, or several meetings, of truckers throughout the Country to consider ways and means of organizing highway-transport centers under this general plan. Such companies might combine along the principal railroad systems or within a state or group of states, and then effect business contracts with railroads, steamship lines and industrial and mercantile firms to handle terminal operation, less-than-carload freight and door-to-door services.

Many such highway or motor-transport companies might form in these or other centers. Their organization, if in conformity with this or any other general plan, would constitute a national system of coordinated transportation. All transportation agencies might not sub-

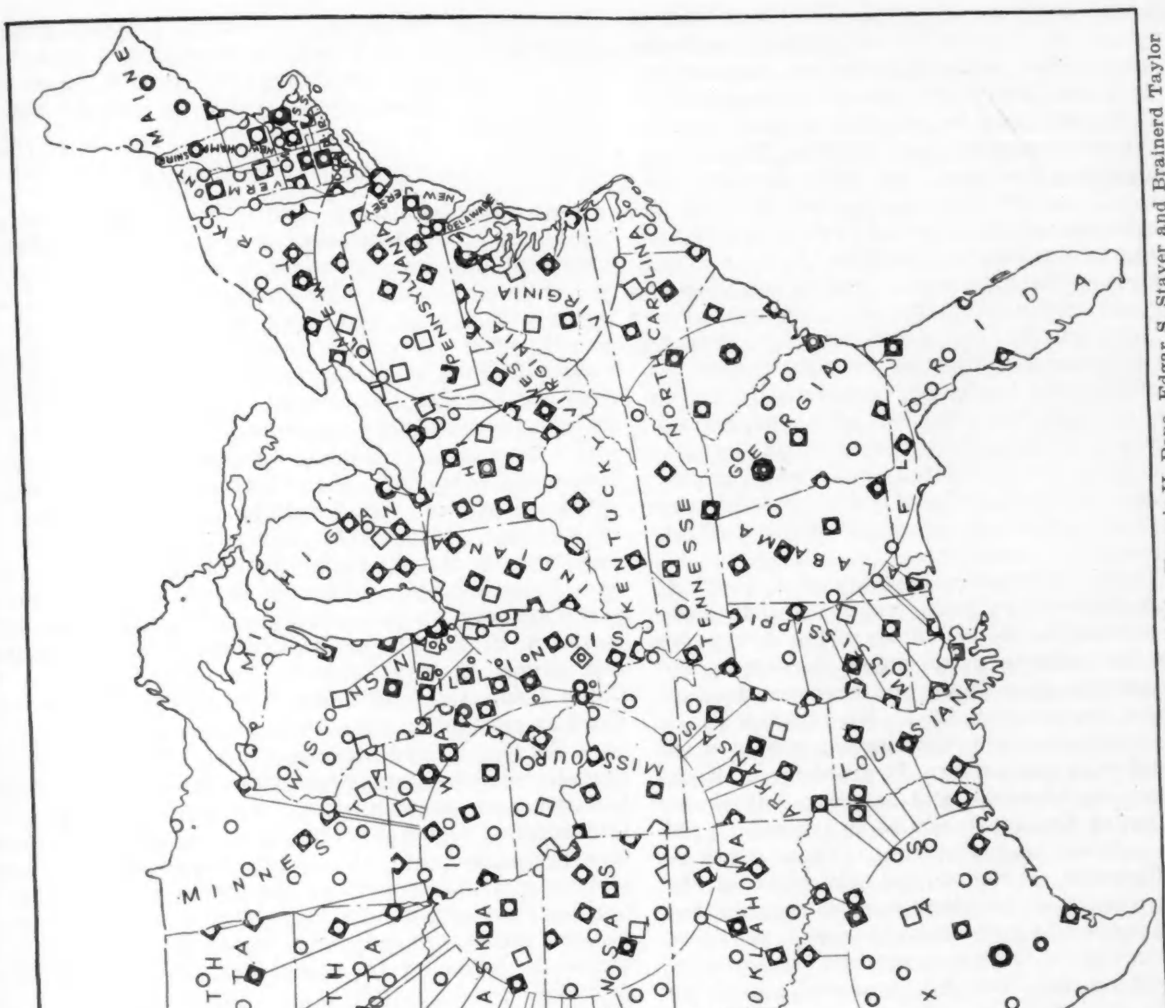

FIG. 4—A NATIONAL MOTOR-TRANSPORT SERVICE COMBINING THE FIELD OF OPERATIONS AND TRAFFIC, SHOWN IN FIG. 3, AND MAINTENANCE ACTIVITIES, SHOWN IN FIG 2

This Map Might Represent Any Public or Private Service of the Future Operating on a Nation-Wide Scale or the General Plan of Future Highway Transportation in Commerce under a National Policy of Coordinating Rail, Water and Highway Transport

scribe to this or any general plan. The fact that a number throughout the Country did subscribe or conform to a general plan which would provide for centralizing coordinating functions over their general transportation systems would be sufficient to establish a skeletonized, national, coordinated transportation service. The formation of such organizations would not stifle the principle of competition. It would tend by natural methods to enforce the adoption of similar or better principles under the stress of business competition, just as it did under military competition in war. General adoption of such a plan would enable all conforming transportation companies to join quickly, for a temporarily combined service, under Government direction or coordination, in emergencies, without the confusion, waste and injury to private ownership that has attended past emergencies. Conforming companies could fit quickly into the general network of national transportation, and could operate with their normal personnel and machinery under a common plan, the general principles of which were not different from their habitual practices.

Even if no such combination as this plan suggests were ever made between railway, waterway and highway-transport companies, the principles of the Army plan might be made to render a great public service by coordinating the policies of railroad and highway development. It forms a reference on file in Washington which the two great transportation industries can use to work out amicably and with mutual benefit problems of highway construction, maintenance and taxation. It shows definitely how motor transport can be organized to aid and not injure railroad transportation. There could be no material differences or commercial war between the two industries, were they to adopt such a coordinating plan as this and cooperate with each other as it provides.

In the construction of highway systems alone, some national coordinating plan like this is needed before we expend hundreds of millions of dollars on highways that may not be in accord with national policies affecting general transportation. The railroad companies as a whole are interested in the general character of the highways that are to be constructed. If truck highways are to be long trunk-line affairs paralleling the railroads and suggesting competition with them in long hauls, we may be sure there will be, sooner or later, a commercial war between the railroads and the truckers. If highways generally radiate for comparatively short distances from railway terminals and stops, obviously to provide highway transportation for the collection and the distribution of railroad cargoes, the railroads must soon give hearty support to such a program of highway construction.

We need, of course, long highway routes from the East coast to the West and from Canada to Mexico, for touring, for national defense and for supplementing railroad transportation in periods of railroad-traffic blocks and other transportation emergencies. These will not be opposed by the railroads in any such national plan as this, which emphasizes the importance of radial and belt-line highways constructed with reference to railway-traffic centers.

Nothing could be worse from the point of view of the automotive industry, or the public, than to spend many millions of dollars of public funds in constructing highways that failed to show a reasonable profit in commercial use. It would not be long before there was developed a situation wherein capital for road and truck construction would be hard to get. Such a situation would surely follow a successful fight by the railroad interests against the construction and the commercial use of automobile highways. The railroads themselves would lose, potentially, very heavily were they forced to take such defensive action through an unwise, blind or uncoordinated and competitive policy in highway-transport development.

Development of the Army Plan

You will find the successive steps taken in developing this plan both interesting and clarifying. The subject is too immense, of course, to show much of any detail in a map of a nation-wide transportation system. I will begin with a city and work up to this national plan. Shortly after my return from France, in March, 1919, I was assigned as Motor-Transport Officer of what was then the Eastern Department, on the staff of the Commanding General at Governors Island, N. Y. The area was a large one, embracing all military activities in the states of New York, New Jersey, Delaware, Pennsylvania, Maryland and Virginia, including the City of Washington. The Army Motor-Transport Service in that area in March, 1919, was completely decentralized, and, in consequence, suffering from the same evils and extravagances we had experienced in our early service in the A. E. F. The centralization of automotive repair and supply in large depots like Camp Holabird, Md., Camp Jesup, Ga., and Camp Normoyle, Tex., was understood as completing the organization of the Motor-Transport Service. Organization of the traffic or operation branch and the organization of centralized administration had not been accomplished. With the decision of the Commanding General of this area, so important from a transportation point of view, to organize a centralized service of motor transport there was presented an exceptional opportunity to make a practical study of the transportation problem here in the United States, immediately following the completion of the A. E. F. experience.

The "Port of Embarkation" situated in New York City, in Brooklyn and in Hoboken, N. J., had a very active and extensive motor-transport service but, because of its separation from all surrounding motor-transport activities, it was also a very expensive one, absorbing all the funds allotted for its operation that should have taken care of many near-by, small, isolated fleets of Army vehicles over which there was no effective supervision.

The plan of centralized service was applied as well as it could be, except to the New York Port of Embarkation, during the difficult period of rapid demobilization of 1919 and 1920 and the consequent loss of experienced motor-transport officers and men belonging to the temporary forces. In February, 1920, the entire motor-transport service of the Port of Embarkation, which had been operating independently at a cost of about $1,000,000 per year, was turned over to the centralized motor-transport service of the Second Corps Area, operated from Governors Island, with instructions from the War Department to reorganize it within the month as part of our centralized service. We were informed that it would be necessary to operate the entire service, in all five States, including the Port, for $78,000 per quarter, beginning March 1, 1920. Such a radical change could not have been accomplished without great confusion under any other plan than this plan of centralization. With the wholesale laying-up of motor vehicles and the discharge of drivers and mechanics that was immediately necessary, transportation problems were greatly complicated. The change was accomplished, however, without exceeding the greatly reduced allotment and without undue confusion.

Under this plan, motor-transport centers, or pools, as they were called, were established in or near the cities of New York, Trenton, Philadelphia, Baltimore, Washington and Norfolk. Experienced motor-transport officers were put in charge and given authority to supervise the organization of all motor-transport operations and maintenance of fleets located within areas designated as belonging to their pools. The more important points in the vicinity of these cities were called sub-pools, and the garages and fleets in their vicinity attached to them for supervision. The entire system was then administered generally and coordinated from the central office at Governors Island, N. Y.

Nothwithstanding the continued loss of experienced personnel by demobilization and increase of work to the reduced forces, there was a steady improvement in the condition of vehicles and a marked economy in their use and repair. By these improvements, quickly and easily effected through center or pool executives, and by coordination with rail and water transport, the volume of movements, which could not be stopped at once with demobilization, was taken care of, the cut and change of service being made within less than one month from the time orders were issued in Washington.

Traffic Center of New York

Greater New York was, of course, the most interesting point in this centralized motor-transport service. A brief description of the New York service will serve as an example of the service indicated in each one of these traffic centers, proposed in the Army plan.

The motor-transport executive who controlled the New York center or pool, as it was then called, had an office at the corner of Eighth Avenue and 33rd Street. Here was a typical setup of a Motor-Transport Center office described in the Army plan. The administrative functions for the whole group, consisting of the New York center and near-by sub-centers, that is, all matters pertaining to personnel, finance, internal coordination and general business with outside agencies were centralized here. The Operation of Traffic branch had its main office here under close executive supervision. The chief dispatcher of the New York center operated from this office, directing by telephone the movement of all vehicles from garages located at 59th Street, Tenth Avenue, Governors Island and one or two other points on Manhattan. Through branch offices and assistant dispatchers at the Army Base in Brooklyn and at Hoboken, he also directed the movement of all vehicles from garages located across the two rivers.

The location of Army garages, shops and service stations and all railroad yards, docks and routes and the general points of Army collection and delivery, were shown on the dispatcher's map. All vehicles were posted on his control boards and their location and duties and status were shown at all times. Officers and men skilled in loading trucks and handling freight went constantly to freight yards and steamship docks to supervise and expedite the loading or unloading of freight. These officials are described in the Army plan as "Cargo Spotters." The loss of time and the confusion at docks and yards, due to the lack of coordination between the railroads and the steamship companies and the outside trucking corporations, was the most outstanding feature of this part of the service. It showed the need of creating cargo spotters in the Motor-Transport Service to work with railroad officials in expediting the exchange of cargoes between rail, water and highway transport. In addition to this freight service, an extensive taxicab service and a motorcycle mail-and-messenger service were also operated.

All calls for the movement of passengers and freight were telephoned to the chief dispatcher, although they might be received originally in branch offices or garages. The chief dispatcher consolidated and coordinated them, arranging for collections and deliveries and the hauling of full loads and return loads. Cargo spotters supervised proper loading. The chief dispatcher issued his trip tickets and way-bills and directed the necessary movements much as though he were a railroad dispatcher.

The chief dispatcher was furnished, from other sections of the operating office, all necessary information regarding vehicle equipment, passengers and cargoes, their origin, destination and description, and terminal and road conditions. He fitted these factors together in making up his plans of operation and orders. With the necessary assistants in his office and in the field, through a well arranged system of telephone communications, he rendered passengers, shippers and consignees a very effective and economical highway-transport service. Under the traffic engineer, the chief dispatcher was in actual control of Army highway traffic at all hours of the day or night.

The Maintenance Branch of this New York Motor-Transport Service, although under the jurisdiction and a part of the center executive's office establishment, actually had its office in another building with its main repair shop. What we call overhaul jobs, that is, any job requiring a vehicle or unit to be knocked down and disassembled, all battery and magneto repairs, body and upholstery work and tire repair of a general character, all these were centralized at the overhaul park or shop, located while under the Port of Embarkation in the heart of the city, but later removed to Sandy Hook, N. J., for economy.

This was a very good city service organized and developed during the war by Port of Embarkation authorities and reorganized later to embrace outside activities on this plan of centralization. It was not perfect under the difficulties of demobilization that hampered its reorganization and operation, but it had distinct advantages over the prior decentralized service. These were sufficiently obvious to receive enthusiastic support from General Bullard, who commanded at Governors Island, and from the War Department which was chiefly interested in gaining effective and economical transportation with its greatly reduced means. The City of Washington also had an excellent city service of zoning and dispatching vehicles, and of coordinating highway transport with rail transportation. Col. G. A. Green, then with the Fifth Avenue Coach Co. in New York City, showed me an extremely well planned system of operating and maintaining a city bus service, wherein a fleet of less than 300 buses gave a general impression that there were 10 times that number. The principles of organization in that company, especially relating to the coordination of traffic and maintenance functions under one head, were in accordance with the best practices in war-time motor transport in France and with this Army plan of a National Motor-Transport Service. There are several commercial plans for operating the motor-transport service of a city bus, taxicab or trucking service which, in many features, are better and more complete than any we have ever had in the Army, I am sure. The best should be available for any national plan. I will not attempt to go further into the details of city or small-fleet operations. It should be enough to know that the Army can furnish the details of a very satisfactory local service if required,

upon which to develop the details of a city or center motor-transport service.

Commercial Organization Under the Army Plan

Assume that, say in Cleveland and its vicinity, a dozen of the principal trucking companies were to combine under the name of the Cleveland National Highway Transport Service. This corporation, we will assume, acquires enough garages and vehicles to carry on an extensive service of highway transportation, not only within the city of Cleveland but through the outlying country for a distance of several hundred miles in any direction. At Painesville, Ashtabula, Youngstown, Canton, Akron and Lorain there are established fleets of the corporation's motor vehicles. Capitalization, franchises, contracts with other carriers for coordinated services and contracts with shippers and consignees are provided for, we will assume. With the standardization of equipment it will be found that this corporation can make all its own major repairs, except out-and-out reconstruction, better and more cheaply in its own centralized shop at Cleveland, under the good shop management of an efficient automotive engineer, than it could get them made by outside agencies, in the towns named above.

Say that this automotive engineer located in Cleveland is given charge, not only of the Cleveland shop, but of the whole system of repair and supply in the area covered by the Cleveland National Highway-Transport Service. He prepares to keep the active vehicle equipment throughout the service up to a fixed number of reliable vehicles by working in close harmony with the traffic engineer of the company. His attention is centered on the problem of maintaining the current, capacity and power of the traffic service rather than the repair of a number of vehicles and the running of a shop and warehouse. His direct responsibility, however, is for good repairs and good shop and warehouse management. The keynote of his repair policy is "unit replacement to all operating fleets," centralizing unit repairs at the Cleveland shop.

The traffic engineer of the corporation controls all vehicles considered to be on an active basis. He cooperates with the maintenance engineer at garages for the regular inspection and the caretaking of active vehicles, and for timely adjustments and minor repairs. He cooperates with railway and waterway-traffic managers at railroad yards and docks. Through his dispatchers he operates the entire terminal and highway service as I have indicated in describing the Army Motor-Transport service in New York City.

Assume further that the two engineers, traffic and maintenance, are controlled and coordinated by the Highway-Transport Engineer who is the general manager of this Cleveland National Highway-Transport Service. This official should combine a knowledge of both departments under him, of cost accounting and finance and the general transportation and industrial conditions which affect the operation of his combined motor-transport service. He maintains a constant supervision over traffic and maintenance matters by frequently inspecting all activities in both branches. He, or his representative, and his inspectors constantly ride over the area covered by the Cleveland corporation, watching operations and gaining, through personal contact, first-hand knowledge of conditions, internal and external to the highway transport service, which affect its welfare.

The management of all offices, garages, vehicles, shops and all elements of this proposed highway-transport service, located within a radius of approximately 50 miles of Cleveland, unless the service becomes too large to manage from one office, is centralized in the Cleveland office. Under the Army plan, this would constitute the Cleveland Highway-Traffic Center. Where the service at cities like Ashtabula, also a traffic center, within the approximate 50-mile limit requires more of an administrative supervision than that given by a garage manager, a branch office called a sub-center is established from the Cleveland center. Sub-centers are also established at traffic centers outside of the 50-mile limit like Mansfield, Columbus and other points, and all highway-transport activities belonging to the Cleveland company, located within 50 miles of these traffic centers, are attached to them for management on the same principles as governed the organization of the Cleveland center, except in the matter of major repairs and general administration. Maintenance and administrative overhead are kept down by centralization as much as possible at Cleveland; local traffic administration and coordinating control only are conducted from sub-center offices. In the Cleveland Highway-Transport Group, thus built up, covering perhaps an area of 10,000 sq. miles or more and composed of one center at Cleveland and as many sub-centers as may be found to be necessary, the principal features are these:

(1) Business administration, general traffic control and detailed maintenance control are all centralized in one office, called the Cleveland Highway-Transport Center

(2) Special functions pertaining to administration, maintenance and direct control over local traffic are judiciously decentralized to sub-centers for execution under general supervision from the main office

(3) Fleets and garages are located wherever necessary

(4) A "Reserve Pool" of inactive vehicles and units, located at convenient points within the area, is established under center or sub-center control. This reserve pool forms a buffer between the operation and the maintenance programs. Garages rotate vehicles in operation, 6 days active, for instance, and 1 day inactive for adjusting and caretaking. Vehicles and units requiring more than minor repairs, necessitating more than 24 inactive hr., are sent to a service shop and the vehicle or unit is replaced from the center or sub-center reserve pool. Maintenance programs work on these reserve pools by the system of unit replacement mentioned heretofore, shipping all vehicles and units requiring disassembling to the main shop at Cleveland. Mechanical units are dismounted from vehicles at service shops only. No dismounting or dismantling is ever allowed at garages

Other groups similar to the Cleveland group might be formed in the same way. If they belong to the same corporation or combination as the Cleveland National Highway-Transport Service, they should centralize their vehicle procurement, their major repairs or overhaul jobs, warehousing and general reserve stocks at some central point such as Cleveland. A combination formed along the Pennsylvania Railroad system might centralize at some point more central for the larger combination like Columbus. A reconstruction park is justified only by an equipment of 400 to 500 vehicles. It is designed to make every conceivable repair or reconstruction required, without outside help. The radius of maintenance control exercised from such a central power-plant in highway transportation, is approximately 500 miles. It may establish branch shops called "Unit Replacement Shops" at other points, wherever the density

of vehicles, the cost of transportation or any other good reason calls for such establishments. Very general administrative and coordinating control over very large areas, particularly with regard to coordinating with railway and waterway transportation, may also be centralized at one of these Highway-Transport Central-Power plants.

These consolidations will never be uniform nor shall we be apt to build up very quickly such a system as this plan shows if they are left to form from the bottom; that is, the forming of natural combinations among the smaller trucking companies, without any guiding plan indicating definite points upon which to concentrate. General-traffic centers should be decided upon by leading transportation engineers in the Country who mean to guide our destinies into general coordination rather than competition. Centralization and coordination of the three services should be worked out upon such points.

The grouping of motor transportation will take care of itself. Highway traffic is subject to change and will always fluctuate with changing conditions of general traffic, as it is affected by peak loads, seasonal changes and changes in our industries. The principal railroad lines and natural-waterway lines should form the arteries of all highway-transport organization. These arteries should be protected as much as possible from sudden and temporary changes in transportation conditions by the operation of highway transport. When an extensive organization in highway transport and the coordination of general transportation is accomplished, concentration of highway-transport equipment can be made in different parts of the Country to bring about the timely movements of peak loads, and in accordance with seasonal changes. The harm done by "fly-by-night" trucking companies at present in taking the cream of business away from local companies could then be controlled. Railroads and steamships could be used to help such truck concentrations.

With regard to the successive steps in developing a nation-wide plan, the Army study of a National Motor-Transport Service, and its place in a National Coordinated Transportation Service, was based on the following premise: "Motor transportation in the United States can never either in an emergency or in daily commercial practice replace the long-haul service of railroads."

Location of Traffic Centers

As a first step in the Army study, an important central section of the United States embracing Indiana, Ohio, Kentucky and West Virginia, was selected. Half a dozen railroads running through this territory were assumed to have combined with each other and with inland-waterway and trucking companies to develop a coordinated transportation service. It was assumed that they agreed to conduct all long hauls of 50 miles or more by railway or waterway, as a general rule, giving the public the choice of the various benefits, that is, speed convenience, cheap tariff, door-to-door service and the like, now at the command of the combined transportation companies because of their water, rail and highway services. They were to coordinate the three services so as to reduce the overhead of administration, maintenance and terminal costs among themselves and feed passenger and freight traffic to each other as much as possible, relying on the producing of new business and on savings for their increased revenues rather than on high tariffs. Inasmuch as short hauls, up to an average limit of 50 miles, were to be made by highway transport, railroad terminals and stops, at least 50 miles apart, were selected along the railroads designated for study to form general "Traffic Centers." At these points, it was assumed, terminal facilities would be developed with a view to cooperating to the fullest extent with the highway-transport service. Intermediate stops and terminal operations, especially with regard to handling less-than-carload shipments were to be eliminated by railroads. Carload collection and delivery stations might still be provided for, when shown to be cheaper in transportation or to give more expeditious service. Commutation and express services might be arranged for by rail service, bus service or both.

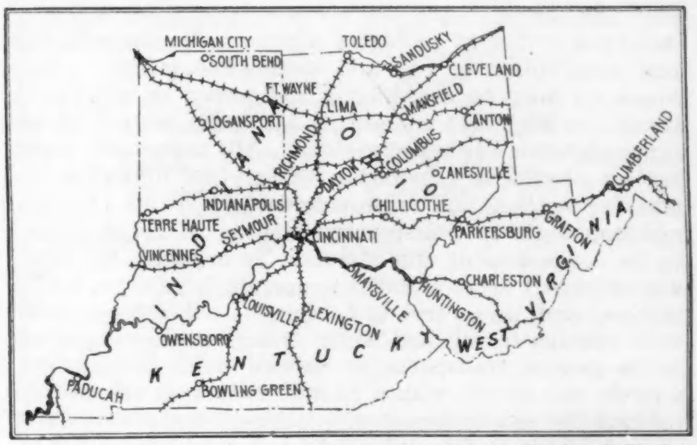

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Fig. 5—General Traffic Centers, Indicated by the Small Circles, Are Selected Points at Which Terminal and Port Facilities Are To Be Developed, Similarly to the Present Development of the Port of New York, with the Basic Idea of Coordinating All Transportation Facilities by the Practical Development of Cooperative Terminal Operations

Water transportation, operating from Lake ports and along the Ohio River, was treated in the same manner as for railways. The map showing the first phase of this study appears as an outline railway-and-waterway map with very few stops in the area under study; it is reproduced as Fig. 5.

Formation of Highway-Transport Centers

The second phase of the Army study concerns the organization of the highway-transport service. The rail and waterway terminals and stops, or traffic centers, constitute foci about which to organize local motor-trans-

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Fig. 6—Highway Transport Centers Are Formed about All General Traffic Centers Shown in Fig. 5

These Are the Points in the Highway-Transport System about Which Highway-Transport Development Should Take Place. Three Classes of Highway, Arterial, Radial and Belt Line, Are Indicated

port and animal-transport services, and from which to develop a system of radiating highways for the collection and distribution of rail and waterway cargoes. These highways must be coordinated and joined by arterial or trunk-line highways connecting all traffic centers in one comprehensive highway system. All important traffic centers should be provided with belt-line highways for transfer services and to provide detours for all through, non-stop highway-transportation so as to avoid adding to the congestion of city streets. To organize the highway-transport service that is to operate from these traffic centers, and to control and coordinate highway traffic with relation to rail and water transportation operating in the general transportation service under development, a circle was drawn with a 10-mile radius on the map to indicate the establishment of a highway-transport center as part of the traffic center established by the railroads. The 10-mile circle which suggests a belt-line highway also indicates the average limit of the city collection-and-delivery service for each traffic center. (See Fig. 6.)

The average limit of country collection and delivery, in motor transportation in areas over which the highway-transport service is to operate from each traffic center, was fixed by boundary lines, established with reference to a circumference drawn about each traffic center with a radius of 50 miles. The imaginary circumference itself might be used, although natural boundaries like rivers, mountain chains, railroads, highways or State and county lines are preferable. In selecting these boundaries the 50-mile radius was used as a general guide only. Local conditions govern in each case.

The establishment of highway-transport centers and sub-centers and their grouping for convenience in administration and traffic control, as described for the assumed Cleveland National Highway-Transport Service, was indicated by the approximately 50-mile boundaries and by colors as shown on a third map of the area under study. (See Fig. 7.)

The organization of each group is similar to that which I have described for Cleveland and its vicinity. The vehicle equipment employed at each center depends upon a calculation of the tonnage and the character of the different commodities to be handled, road conditions, standardization of vehicles and other highway-transport considerations, presented for each center but considered and determined for the entire highway-transport service, as it is organized and developed.

Amplification of the Army Study

This sample initial study was sent to all the principal Army headquarters in the United States, with a short pamphlet of instruction. Transportation engineers at these headquarters were directed to submit to the War Department highway-transport map-studies of designated areas, to be made in accordance with the principles of this sample study, applied to actual local conditions. These studies have all been received and reviewed in the War Department. In some cases they were sent back for revision, but were finally accepted and combined to make a single map-study of highway transport for the entire United States.

In the original joint study, made by officers in the Engineer Corps, the Quartermaster Corps and the General Staff, both in the War Department and in the field, all over the United States, the principal roads shown in the well known Automobile Blue Books were used, in order that we might all work on the same highway system, representing roads already in existence and in some degree suited to highway transportation. These roads are far from what is required for national highway transportation, but they are better than Federal and State highway projects for immediate purposes. Further studies are being made with the American Automobile Association map-system of roads. Here again we are confronted with the great defect in our network of transportation. The absence of improved roads and bridges suitable for highway transportation appears as a serious weakness in our national transportation system. Industrial progress in unimproved areas is seriously retarded. Were motor transport required to operate over these unimproved roads in public emergencies, the cost in damage to motor-vehicle equipment would be incalculable. (See Fig. 3.)

The problem of organizing a National Highway-Transport Service is best considered for the present by leaving out of the maps illustrating its organization all highways and even the basic railroads assumed for the original study, retaining only the traffic centers and the grouping of the motor-transport centers and sub-centers determined upon by the combined Army study. These represent most of the commercially strategical points in any system of national transportation which may be devised. They are near enough to be used in establishing a basic organization, or a basic policy.

The study now appears as a highway-transport traffic-map showing the traffic centers in the field of operations for the Chief of the Operation or Traffic Branch. Through these traffic centers pass most of the railways, waterways and highways, actual and projected, which make up our entire national network of transportation. Any national highway-transport service must operate over such highways as already exist in this network, whether they operate independently in decentralized trucking or systematically in organized highway transportation. Highways that exist can be drawn-in locally. Radiating and belt-line highways required, as well as trunk-line highways urged for early construction under approved State and Federal highway projects, can be drawn-in by each private company, State or Federal group, that may make a detailed study of this plan.

This study of the organization of a national highway-transport service which has been made in the Army from the *traffic* point of view as the point of original and not the automotive procurement, repair and supply point of view, as heretofore, is not complete and would never amount to a row of pins unless supported by a parallel plan of automotive maintenance. The completed traffic plan was therefore submitted by me as the Army's Motor-Transport Traffic-Engineer, so to speak, to the Army's Motor-Transport Maintenance-Engineer, Lieut-Col. E. S. Stayer, who has in turn submitted a plan of automotive procurement, repair and supply, illustrating the organization of the maintenance facilities to maintain this plan of a National Motor-Transport Traffic-Service. Assuming a permanent highway-transport organization of the greatest magnitude to emphasize the principle of centralization which produces the greatest economies in highway-transport maintenance, Colonel Stayer, who has lately succeeded Col. F. H. Pope as chief of the Army Motor-Transport Service in the Office of the Quartermaster General, can best describe the details of all maintenance plans and operations. I will point out its principal features to show its relation to the Operation Service, which is of primary importance in all transportation schemes.

As effective and economical highway traffic and practical coordination with rail and waterway traffic were the deciding factors in centralizing and decentralizing

control over operating functions in the traffic study, so effective and economical maintenance and the coordination with traffic functions decided the centralization and decentralization of control over maintenance functions in the maintenance study. This plan of maintenance organization differs from all others hitherto known in the Army in that it is designed to maintain a centralized highway-traffic service, not merely the vehicles operated. It recognizes the necessity of a highly organized traffic service as the crux of the whole subject of highway transportation, and is prepared to sustain that service at the very highest possible peak of efficiency by keeping the reserve mobility of the traffic service as near the maximum as possible, the maximum reserve mobility being the initial point of starting transport operations with an equipment of entirely new vehicles of the most durable character.

The reserve power and capacity of the Motor-Transport Service is sustained under this plan by maintaining a pool of reserve vehicles and assembled units between the fluctuating traffic requirements and the necessity of maintaining regular repair programs in shop operation. By a rigid system of rotating all active vehicles through the reserve pool for weekly examinations and adjustments, and by the replacing of vehicles and units needing more than a minor repair from "ready-for-service" inactive vehicles and units in the reserve pool, the active vehicles in traffic are always operating at their mechanical best, with reserve mobility to carry them through traffic emergencies. In the meantime, the repair programs in shops go on regularly, economically, with uniform and standard workmanship, unhurried by the irregularities of fluctuating traffic conditions.

In decentralized trucking, this idea of making unit and vehicle replacements through a reserve pool is merely a theory. It has never worked under a decentralized system. Independent truck and fleet operators will never let it work. Each one, as a rule, operates his vehicles until they positively cannot be operated any longer, and then he forces emergency repairs at any cost under a pressure that destroys maintenance programs and all chance of economical practices. It is a matter of organization and engineering administration. It involves an economical question of many millions of dollars every year in both commercial and military motor-transportation.

The problems of organizing motor-transport traffic and motor-transport maintenance are very different. Control over the functions of these two divisions should not be decentralized to the same degree. Traffic control governs in the Operation or Traffic Branch, while shop and warehousing management, and control over procurement and expenditure of equipment and supplies governs in the Maintenance Branch. This is the chief internal reason why a third branch, the Administration Branch, is necessary in motor-transport organization. A general Executive Branch is required to permit specialization in both traffic and maintenance and at the same time to insure their amalgamation and coordination.

Maintenance Activities in the Army Plan

The maintenance plan in this Army study appears on a separate map without traffic features that is reproduced in Fig. 2. At, or near, centers and sub-centers, established to control motor-transport traffic and along isolated highways of great length, service shops or parks are established, indicated on the maintenance map by squares. These shops make minor repairs which require the vehicle to remain inactive more than 24 hr.

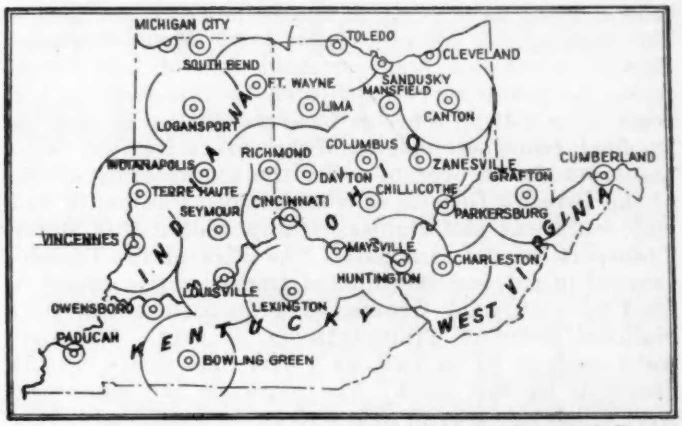

Fig. 7—A Motor-Transport Service Formed about the Highway-Transport Centers Shown in Fig. 6

The Average Limit of Truck Hauls Is Established about Each Center by Imaginary or Natural Boundaries Determined by an Approximate Radius of 50 Miles. Motor-Transport Centers, or General Administrative Offices, Having Control over General Business, Highway Traffic Control and Minor Repair Work, Are Established at the Most Important Traffic Centers. Nearby Centers Are Designated as Sub-Centers and Only Traffic and Minor Repair Functions over Local Fleets Are Decentralized to Those Branch Offices. The Service Shown by This Map Is Divided in Eight Groups, Each with One Motor-Transport Center and Several Sub-Centers

They also remove and replace all engines and other mechanical units which require extensive repairs. They do no disassembling of vehicles or units, but ship them to unit repair shops or reconstruction shops in exchange for "ready-for-service" vehicles or units.

At selected points, conveniently located to groups and centers, where vehicles are dense and the volume of repair work justifies, unit repair shops or parks are established, indicated by hexagons. Engines, radiators, batteries, magnetos, rear-axle assemblies and other demountable units removed from vehicles at the service shop and sent to unit repair shops for all repairs requiring disassembling, are repaired at these shops on a wholesale plan, or plan of quantity production.

At centrally located points, having excellent supply and transportation facilities, the larger shops and warehouses of the reconstruction parks are located. These, as I have said, are central powerplants in motor transportation. They are indicated by octagons. The practical radius of activity of these parks is about 500 miles, indicated by the very large circles. Where service parks and unit repair parks lie outside the zone of activity of a reconstruction park, they are assigned to the most convenient one for supervision, as indicated by connecting radial lines, so as to preserve the principle of centralization of control over all maintenance functions.

Procurement offices, indicated by small circles on this maintenance map, are located at such natural automotive procurement centers as Chicago, Detroit, Akron, and New York City. The principal maintenance offices are located at the reconstruction parks, from which a general control over automotive repair and supply is exercised for an entire system, as indicated by zones and radial lines connecting isolated maintenance points with the 500-mile circumference of a reconstruction park.

Finally, we reach the map of the completed motor-transport organization in our Army plan of a National Highway-Transport Service reproduced in Fig. 4. The traffic and maintenance centers are brought together in one comprehensive plan. The administrative officers are assigned to stations, according to the importance of these grouped activities, to govern the internal motor-transport organization and apply it to whatever external purposes

may employ its service. A final administrative head as for instance the Chief of the Army Motor-Transport Service in military transportation, controls and coordinates the entire service indicated by this map, in true correlation with all other national transportation systems. In final coordination, such chief executives of motor transport should operate under the coordinating control of the Director General of whatever combination of railway, waterway and highway transportation this Motor-Transport Service is a part. The office of the Director General in national coordinated transportation might be filled by a Director General of Transportation or by a National Board of Transportation, or both. The highways used, or to be used, as I have said before, can be drawn-in on this plan. The railways and waterways with which this service is to operate in a national system of coordinated transportation can also be drawn-in. The map then becomes a general map of coordinated transportation for use in general traffic control, and a basis for general policies.

This study is purely a general transportation study with especial emphasis on the question of organizing highway transportation, using the motor vehicle as the principal coordinating factor. It forms a basic plan upon which any plan of military or commercial transportation can be worked out in detail. A study of the highway-transport service of the United States Post Office Department, the Standard Oil Co. or any general or specialized service of transportation which might be proposed for organization, would look the same in general character if made in accordance with the principles which governed in this study.

That the principles used are simple and broad in their scope is amply proved by the similarity of studies, based upon them, which have been submitted by Army engineers in New England, the Middle and South Atlantic States, the Northern and Central States and the Pacific coast. The study, as I have shown it, is a composite study of the Nation's network of transportation, made from many angles of consideration, all based on the world's greatest experience in transportation. It is offered by the War Department to all who are interested in the development of our Nation's transportation, as a piece of national transportation research and a willing contribution to American commerce by the United States Army.

IRON AND SEMI-STEEL

WROUGHT iron is made by the puddling process and is the purest variety of commercial iron, usually containing less than 0.08 carbon and approximately 1.00 per cent slag, the peculiar orientation of which is responsible for its remarkable resistance to corrosion and for its fibrous structure, allowing a large degree of plastic flow or movement within its crystal aggregate that makes it weak in compression. Wrought iron is very ductile and malleable, bending through an angle of 180 deg. or doubling flat on itself without breaking. It melts at a temperature of 1600 deg. cent. (2912 deg. fahr.) and is still sluggish and viscous at temperatures so high that it is not practical to cast it into molds.

Malleable iron is cast iron of a special chemical composition, melted in a reverberatory or air-furnace, and on rare occasions in a cupola, and then cast into molds of its final form. The resulting casting is entirely white or all carbon is present in the combined form as iron carbide, cementite, Fe_3C. Annealing in iron scale, Fe_3O_4, and sand packing at a temperature of from 760 to 925 deg. cent. (1400 to 1697 deg. fahr.) for a period of 40 to 60 hr. changes the carbide to the free amorphous carbon and ferrite, thereby rendering the casting malleable and very ductile at room temperatures.

Malleable iron is lower in carbon, silicon, sulphur, phosphorus and manganese than gray cast iron. It is, therefore, more viscous and must be cast at a higher temperature than the former; consequently it requires greater skill and care, on the part of the molder, to avoid misruns and excessive washing and scoring of the mold from the highly heated metal. Malleable-iron castings combine the advantages of ordinary gray-iron castings with respect to the ease of production and cost, with a ductility and strength approaching that of steel.

Cast iron differs markedly from wrought iron and steel, chemically as well as in physical characteristics. It has a coarse, crystalline grain structure, lacks toughness and is brittle at all temperatures below its melting point. The tensile-strength is not affected at temperatures below 1000 deg. fahr. but falls off quickly near the critical range and becomes very low at high temperatures. It melts at a low temperature, 2200 deg. fahr., and passes suddenly into a very fluid state and fills the molds well when cast.

Gray cast iron contains a large amount of graphitic carbon, appearing in an irregular elongated aggregate of crystalline carbon resembling curved flakes or plates imbedded in a matrix of ferrite and cementite. The percentage of free graphite or graphitic carbon in gray cast iron depends upon the percentage composition of the other chemical constituents of the iron, such as silicon, manganese, sulphur, phosphorus. Silicon more especially influences the separation of graphite on the cooling of the iron from the liquid to the solid. However, ordinary machinery iron contains approximately 3.00 per cent carbon and 0.50 per cent combined carbon.

Semi-steel is gray iron of such composition with regard to silicon and carbon as to give the highest possible strength in conjunction with the other properties and characteristics inherent in gray cast iron. Properties such as high compressive strength, low coefficient of expansion, rust-resisting qualities, low melting point, high abrasive resistance, great hardness, wearing properties and others are obtained by melting a mixture of foundry pig iron, gray iron scrap, and from 10 to 40 per cent of low-carbon steel-scrap in a cupola and casting the liquid iron into green-sand molds.—From an article by W. J. Merten in *Forging and Heat-Treating*.

The Coordination of the Motorbus and the Street Railway

By C. D. EMMONS[1] CLEVELAND AUTOMOTIVE TRANSPORTATION MEETING PAPER

THE author believes that, except for aerial navigation, whatever new forms of transportation may be developed must be auxiliaries to the rail lines, and that the problem is to bring about coordination between railroads and railways on the one hand and all remaining forms of transportation on the other. He concentrates upon coordinating motorbus and motor-truck service with rail service.

He reviews the attempts already made to displace the railways and substitute motor-vehicle service, quoting statements of fact and of opinion from the press, discusses the limitations of motorbus service and considers the factors of expense that apply to the motor vehicle when it becomes a common carrier. The elements of motor-vehicle operation, the necessity of educating the public to understand the conditions that control the cost of transportation, destructive competition and motorbuses as railway auxiliaries are treated also in some detail.

IN the first place, it is well recognized that no form of transportation has yet been devised that can take the place of the railroads for long-distance travel, in speed and comfort, and that of the electric railways for mass transportation. They unquestionably carry the greatest quantities of goods and the largest numbers of people at the lowest cost. Whatever new forms of transportation may be developed, with the possible exception of vehicles navigating the air, must be auxiliaries to the rail lines. I do not say this because of any prejudice favorable to railroads and the electric railways, but because this finding is a fact that has been amply demonstrated. The problem before everybody interested in transportation, therefore, is to bring about coordination between the railroads and railways on the one hand, and all other forms of transportation on the other. At this time we can leave out of consideration airplanes and airships, steamboats and canal transport, and concentrate our attention upon coordinating motorbus and motor-truck service with rail service.

A few years ago, when the electric railways were suffering from the effects of high wages, high costs of materials and depleted man power, there were those who thought that the motorbus or jitney could take the place of the established electric railways. Most automotive engineers are well aware of what happened in several communities. There was Des Moines, Iowa, for one example, and Bridgeport, Conn., for another. In both these cities the motor vehicles that were pressed into service when the electric railways were forced to stop operation failed to serve the public. I am not saying that motor vehicles properly designed for handling mass transportation and operated by an organization that has had adequate transportation experience, could not take care of the transit problems of a community satisfactorily, but I do say that no motor vehicle that has been designed so far can give the public the service that it has a right to expect, except at a rate of fare that would be very much greater than the rate charged by the electric railway for the same kind of service.

It is interesting to look back upon the experience of some of these cities where the attempt was made to displace the railways. In Bridgeport, Conn., the public felt so certain that jitneys and motorbuses could give it the service it wanted that the people refused to recognize the justice of any argument the electric railway might advance. Eventually the electric railway was compelled to stop serving the people. The city was without street-car service for several weeks. A Bridgeport newspaper that had been antagonistic to the electric railway in reviewing this situation recently said that:

> The substitute motor transportation cost the merchants hundreds of thousands of dollars' worth of business in a few weeks' time simply because the people from outlying sections of the city were not able to get into the city for trade. There were thousands of people who would not travel at all, finding it better to put up with the inconvenience of staying at home than to submit themselves to the danger, annoyance and confusion of crowded and unregulated jitney travel.

This is a mild statement of the facts. Bridgeport, like Des Moines, recognizes that the backbone of its transportation system is the electric railway. Nevertheless, it recognizes the value of the motor vehicle. The same newspaper also said:

> The motorbus properly operated has come not only to stay as a transportation factor, but to play an increasing role in the development of new territory. The right system would include a combination of both kinds of service, each operating in the field to which it is best suited, *but the service should be properly coordinated under one management.* There is but one way to attain such a combination in Bridgeport. That is for the electric-railway company to acquire the present motor-vehicle lines and operate both trolleys and jitneys under the supervision of the Public Utilities Commission.

In an article entitled Riding on Rubber[2], Edward Hungerford makes the following statement:

> The proponents of the street car in city traffic as against the motorbus are apt to make much of the supposed inability of the latter vehicle to handle great numbers of people within a reasonably short space of time. Yet nightly in crowded New York more than 180 motor coaches an hour are operated in a single direction, or on a headway of something less than 20 sec. Each of these double-decked buses seats 51 persons, standees are never permitted, which means that in the course of an hour close to 10,000 passengers are picked up and carried north through New York's home-bound rush in the evening.

This statement is not entirely accurate. During a check made on a typical week day in March, at Fifth Avenue and 43rd Street, New York City, between the hours of 4:35 and 6:05 p. m., or 1½ hr., 205 buses were operated northbound. This is an average headway of

[1] President, American Electric Railway Association, New York City; also president United Railways & Electric Co. of Baltimore, Baltimore.

[2] See *Saturday Evening Post*, March 24, 1923, p. 44.

26 1/3 sec. During the heaviest 5-min. period, an interval of 17 sec. was maintained. During the heaviest 60 min. of travel, the average headway was 24.2 sec., or 149 buses. For the entire period, the 205 buses carried 7189 passengers.

Now compare this with other methods of mass transportation. The same number of people could be transported in 7 subway trains of 10 cars each, with approximately 100 people per car and, at the minimum headway operated in the subway of 1 min. and 48 sec., they would have completed the hauling in 12 min. and 36 sec. This, of course, is far less than is carried in these trains during the rush-hours. The trains evenly spaced, would operate under a headway of about 13 min. The speed at which the people would be transported to their destinations, of course, would be very much higher. Forty-five modern two-car surface trains could have carried this entire number of people and, operating on a 45-sec. headway, would have handled them in less than 34 min., or, if spread over the 1½-hr. period, on a 2-min. headway.

In the instances I have quoted, some standing passengers are provided, but one can easily figure that the loads proposed in the subway trains and in the two-car surface-trains are much less than is usually handled during the rush-hour period. If only seated passengers were to be handled in subway cars, obviously many more seats could be provided in the present cars and still leave sufficient room for passageways.

Limitations of Motorbus Service

One point that must not be overlooked when discussing the Fifth Avenue bus service, or any similar service in this Country, is that these services are all supplementary and in no case do they handle the mass or bulk of the passengers who want to ride. In other words, do not let us blind ourselves to the fact that, so far, in no large city, and I do not except London in this respect, have motorbuses alone been able to handle the mass of passengers. In all cases, where conditions approaching the American rush-hour obtain, rapid-transit facilities or the larger capacity surface-cars are needed.

There is no conflict between the electric railways and the motor-vehicle industry. Instead there is the heartiest cooperation. There are many electric railways in the United States that are using motor vehicles in connection with their transportation service. On the other hand, there are many railways that are suffering from parasitic competition from unregulated motor vehicles. These railways serve communities that have not yet learned that these two forms of transportation cannot operate in competition with each other without one or the other going broke. It is for the people themselves to decide whether they wish to keep the railways or the motor vehicles. I think all sensible men will say that if the motor vehicle will serve a community better and at a lower rate of fare than can be offered by an electric railway, then by all means junk the railway. The fact, however, is that except in very small communities the railway is ever so much cheaper to operate than the motor vehicle.

In the illuminating, almost prophetic address by Vice-President Elisha Lee of the Pennsylvania Railroad Co. before the Society at the 1923 Annual Dinner, entitled The Motor Truck and Our Railways[3], I was struck with his remarks on coordination, not competition, and on the needs of the citizenry of this Country for the cooperative services of railroads and motor vehicles. His speech will reward re-reading and study.

This problem of competition between railways and motor vehicles has become very acute in some places. Massachusetts has paid particular attention to it, as have Pennsylvania, Maryland, Connecticut, Rhode Island and other States. The Massachusetts Department of Public Utilities, in January, 1923, submitted a special report to the Legislature of that State in which it discussed this problem very extensively. I will quote a paragraph or two from its report. It says:

> The motor truck has, of course, had very little effect upon the street railways. The jitney and private automobile, however, have had an enormous effect upon them which is so obvious and so well known that it needs no recital. The result has been that about 400 miles of street-railway lines in this commonwealth have been abandoned. Interurban traffic on street railways in many communities is moribund; semi-urban traffic on them has been seriously injured, and even metropolitan traffic in the heart of Boston itself has been injuriously affected. Besides that, and this fact is not perhaps so generally recognized, the automobile has become the biggest electric-railway hazard and costs street railways large sums of money in safety measures and in suits. It also affects injuriously street railways in numerous other ways.
>
> Constant attempts are being made to force large expenses on street railways for the benefit of automobile traffic. It was, for example, suggested a short while ago that the subway edifice in Harvard Square, Cambridge, should be removed at a substantial cost to the railway to make that square safer, while a rerouting of the automobiles during rush-hours would have accomplished the purpose better. A number of citizens have just appeared before this Department urging upon us the abolition of one-man cars in Malden, partly because of congestion in certain parts of Malden due to these cars, and to the promiscuous and unrestricted parking of automobiles. These two cases are typical of many that are constantly arising where the thought of restricting automobile traffic appears to be regarded as entirely out of the realm of possibility and the contention is that street railways, and this, of course, means the riders upon them, should be subjected to large additional burdens to prevent inconveniencing the automobilists in the slightest degree. This attitude, and the pressure which results from it, is costly to the street railways and hence to their patrons.

The Massachusetts Department of Public Utilities also points out the effect of automobile traffic upon the State highways. It says:

> It is very doubtful whether a roadbed has yet been developed which will stand for any substantial length of time the constant wear and tear of this heavy traffic. It is, at any rate, clear that our older highways have had to be, and will continue to have to be rebuilt on a far more expensive scale, and that both these and the newer highways are going to cost a sum for maintenance which would have been regarded as extravagance a few years ago. But this is not all. Those interested in motor-truck transportation have recently pointed out that it will be necessary to widen some of our roads to 30 ft. to take care of their traffic and that, in general, special roads for trucks must be built, with a width of probably 20 ft. It is not surprising that the advocates of motor trucks take this position. Why should they not, in view of the fact that these fine highways will be a great asset to them and that they will have to pay nothing for them worth talking of beyond what the ordinary taxpayer does? We believe it is necessary to face the fact that if the commonwealth continues its present policy in this regard,

[3] See The Journal, February, 1923, p. 151.

the construction and maintenance of state highways for motor trucks will cost an ever-increasing and before long a staggering amount. The same thing exactly is happening in the case of bridges, as we pointed out before, and in the case of county and city and town roads.

These words by the Massachusetts commission, which states explicitly that it is not prejudiced against motor vehicles but of which, it says, "We recognize that the automobile, both freight and passenger, is a useful appliance for the purposes of society," are worth pondering. The commission recommends to the Massachusetts Legislature that a board be created to consider among other things the following: First, proper compensation for the use of highways and bridges by motor vehicles. Second, the creation of areas and congested districts from which motor vehicles would be excluded wholly or partially. Third, the subjection of operators of motor trucks for hire to the jurisdiction of the Department of Public Utilities to the same extent and in the same manner as other well-recognized common carriers.

Motor Vehicles as Common Carriers

It almost universally develops that when the motor-vehicle common-carrier is subjected to the same burdens of taxation and to the same regulations that apply to the electric railways, they find it impossible to operate successfully. You are well aware that electric railways in many states are required to carry many extraneous burdens. They have to pay for the paving between the rails and for a distance outside their rails; they have to pay for watering streets, for snow removal; they pay a percentage of their gross income, whether they have any net income or not, in taxes to the state; they pay in many communities a tax on their income to the community; they pay franchise taxes, license fees and various other charges that put a very heavy load upon them.

The motor vehicle that is competing with them, in many communities, has free use of the paving for which the electric railway pays. In many states motor vehicles have not yet been classified as common carriers; there is no regulation of the rates of fare or charges for carrying freight; in many places they are not under bond, so that if a passenger becomes involved in an accident he has but slight chance to recover damages. They do not pay a percentage of their gross income to the state or communities; they do not have to help water the streets. Put upon the motor vehicle the same burden that the railway carries and fares that will permit successful competition with the railways become out of the question.

Perhaps these facts had something to do with the statement of Alfred Reeves, general manager of the National Automobile Chamber of Commerce, in a recent address. He said:

> Bus and truck lines have not all been successful generally because of mismanagement or because of routes that furnish insufficient return. All this means that the railroad men are the proper ones to take charge of bus and truck operations, making them feeders to the trolleys and steam lines.
>
> The motor industry is anxious to cooperate in every way that will make for each department of transportation finding its proper place, and this means efficiently serving the public.

Mr. Reeves' statement is further borne out by the recent reports of the Motor Vehicle Conference Committee on the Regulation of Motor Vehicles, the reports being almost in complete harmony with the attitude of the electric railways.

The automotive industry must realize that it cannot foster a service that engages in ruinous competition with rail lines, whether they be steam or electric. I venture to say that there are not enough motor trucks in the United States to bring to your automobile factories the raw materials that are necessary for the construction of motor vehicles. Nor are there streets wide enough, nor automobiles enough in any community, to carry the employes of your factories to and from work as expeditiously and cheaply as they are carried by the electric cars. These facts are self-evident and the National Automobile Chamber of Commerce takes the only proper step possible when it stands for coordination of motor vehicle and rail service. For example, a recent traffic survey in the City of Baltimore, Md., of the travel into and out of the business area showed that, while the automobile comprised 73 per cent of the total movements and the street cars only 27 per cent, the street cars actually accommodated almost 89 per cent of the total travel, while the automobile only accommodated about 11 per cent, disregarding the very small percentage of horse-drawn vehicles.

At the last Convention of the American Electric Railway Association in Chicago in October, 1922, there was unanimously adopted a report by the Committee on Trackless Transportation in which the following statement was made:

> The basic transportation service in any community is and will be furnished upon rails. Trackless service will be found supplementing, but not competing with, that of the electric railway. The bus may be considered an additional equipment for the street railway. If the service of both means of transportation are coordinated, the net return of each will be reflected in the net return of the electric railway. New capital is annually required in the operation of a street railway. Part of this new capital may well be used in the development of trackless service in the field above mentioned.
>
> The possibilities of development of transportation with railless vehicles should interest the industry greatly and your committee feels that the study of the development in the design and construction of railless vehicles and their adaptability for highway transportation should be carried on further by a committee of your association.

You will see from this that the electric-railway industry is on record for coordination of motor vehicles and railways and it is most gratifying to find the National Automobile Chamber of Commerce adopting the same attitude. Working together, we are sure to solve the problems that beset us.

Motor-Vehicle Operation

There is a Committee of the American Electric Railway Transportation and Traffic Association that devotes its entire time to the study of motor-vehicle operation. It is made up of men who have spent practically their entire lives in the transportation business. They know what is necessary in any vehicle for economical and satisfactory transportation. The assistance that this committee can render and will render you men who are spending your time designing vehicles and engines will be very great. The transportation industry no longer will take any old kind of bus body put upon a standard truck chassis. The vehicle must be designed for the kind of service in which it is to be used, and let me say that we have found the motor-vehicle builders very willing to adopt suggestions that we have made. As I said before, there is no conflict between us, we are working together in complete harmony.

It is in this field especially, it seems to me, that the Society of Automotive Engineers comes into play. You are particularly interested in, and should be the ones to solve the needs from a design standpoint of automotive vehicles. The operating men, who are handling the public, are, in general, the ones best able to say what is needed to furnish to the public the most satisfactory character of vehicle for transportation, and it is the duty of the engineers to incorporate these needs into actual designs.

The question of light weight and economical operation are of particular importance from the standpoint of the financial returns to the operator. In connection with the need for lightness, there is not only less cost of operation and maintenance, but it lessens the wear on the roads and, in a number of cases, because of the tax laws on the books, there is a particular demand for light-weight vehicles. In Maryland, for instance, there is a tax of 1/6 cent per seat-mile for vehicles weighing more than 8500 lb.; the tax between 7000 and 8500 lb. being 1/15 cent per seat-mile, and you can easily imagine why we want a light automotive vehicle in Maryland, when there is an increase of almost 200 per cent in the tax basis the minute you go over 8500 lb.

The comfort and convenience of passengers is a very necessary factor in design. The appearance of the car is another thing that has a marked effect on public sentiment and involves, of course, in addition to the initial design, proper upkeep. Convenience in handling by chauffeur operator and easy riding qualities making for comfort are of great importance. The question of designing automotive vehicles with special reference to safety features is another side that must always be kept in mind; adequate lighting; ease and rapidity of acceleration; low steps and many additional details of construction, all of which bear upon the financial return to be expected; the comfort of passengers and the public-relation side of operation, which last is most important. You will see, therefore, from what I have just outlined in rather a sketchy fashion, that the automotive engineers need to cooperate most closely with the operators in order that the most satisfactory type of automotive vehicle may be evolved.

Cost of Transportation

It seems to me that before we can have coordinated transportation-service we must have a public educated to understand the cost of transportation. In the past, the troubles of the railroads and the electric railways have been due to public ignorance of railroad and railway conditions. An individual who himself earned 75 to 100 per cent more wages than he received in 1914 and who paid, without a murmur, 75 to 100 per cent more for his clothing, fuel and other necessaries of life, would wave his arms in the air and wax wrathy when the railroad or the electric railway was compelled to increase its freight or passenger rates. This individual was blind and deaf to the fact that everybody working for the railways had had his pay raised; that every bit of steel, copper, wood and materials of whatever nature, cost more than they did in 1914, largely because of labor costs in their manufacture, and that there was no possibility of the transportation companies getting the money with which to pay higher wages and increased costs of materials except through the charges made for carrying freight and passengers.

There are still some communities where the people will not recognize the fact. In some of them they are deluded by demagogic politicians and a certain type of sensational newspaper that seeks profits at the expense of the public welfare.

In Detroit, where in May, 1922, the city took over the electric-railway lines formerly operated by a private company, there is now indignation on the part of the city councilmen because several hundred jitneys are competing with the city-owned trolley cars. An ordinance was passed last fall, designed to prevent jitney operation, but an injunction was obtained recently that temporarily nullified the ordinance. Whether this injunction has been vacated I am not aware, but it is a most interesting fact that when the private company operated the electric cars in Detroit the city seemingly did everything within its power to encourage jitney competition. Now that the city owns the railways and is putting on buses of its own, the city fathers recognize the injustice and the uneconomic conditions that accompany competitive transportation services in a given community.

Destructive Competition

Connecticut and Rhode Island have come through rather strenuous experiences with destructive transportation competition. In Connecticut, many towns that formerly enjoyed electric-railway service are now without it because of the dismantling of the railway that formerly served them. Three of the four electric-railway companies in that State are in the hands of receivers. Not until this condition came about did the people awaken to the situation that confronted them. Then the Legislature enacted laws making jitneys common carriers and subjecting them to regulation by the Public Utilities Commission. The Rhode Island Legislature enacted similar laws. The Massachusetts Department of Public Utilities recommends similar legislation in that State. Pennsylvania and Maryland had taken action before the New England states acted. In the Middle West, progress has been slow and interurban railways have suffered very severely. Indications are now that the people are awakening to a realization of the misfortune that would impend were these railways compelled to cease operating and relief is confidently expected.

Where electric railways have placed motor vehicles in operation, they have for the most part been successful. You realize, of course, that every time a real-estate operator starts to develop a tract remote from an electric-railway line, he and those to whom he has sold lots frame a petition to the railway or to the community authorities, demanding transportation service. If he does not get it, he becomes indignant. What he is really asking is that the railway company should, without charge to him, provide a service that will be operated at a loss but that will increase the value of his property. The unfairness of this attitude is obvious.

Real-estate owners are well aware that a gas company or an electric-light company will not extend mains and power lines into a new tract unless it is guaranteed a certain amount of business or unless there is a sufficient number of property owners who will take sufficient service to make a return upon the investment certain. The soundness of the gas company's and the electric light-company's attitude is well recognized. How strange then that, when the same favor is asked of an electric-railway company and it is not immediately granted, the property owners feel that they are not being accorded just treatment!

In Cleveland there have been situations identical with such as I have mentioned and the railway company, with

(*Concluded on p. 464*)

English Cartage-Practice a Standard for Our Railway-Terminal Trucking

By F. C. Horner[1]

Cleveland Automotive Transportation Meeting Paper *Illustrated with* Photographs

THE author discusses the factors that must be considered in solving the transportation problems and then describes the operation of the English-railway cartage-system in some detail under the two main divisions of delivery and collection. An important feature of the system is that of the control afforded by locating a controller, or dispatcher, in a central office and holding him responsible for the movements of the carmen, or drivers. The details of this control are explained.

The field for the motor truck in railroad-terminal service is outlined and a presentation is made of the merits and demerits of unit containers, together with an illustrated description of the English "flats," or demountable bodies.

Other subjects treated include cartage costs, tonnage hauled, unified control of cartage and expressions of opinion quoted from numerous English trade organizations.

SINCE the expense and delay that now exist will eventually prove disastrous to both the railways and the traders unless we find a solution for the problem of the cartage of the miscellaneous-goods traffic at our railway terminals, I will point out some of the evils of our present methods of collecting and delivering miscellaneous goods at the railway terminals, and then describe how the English perform this kind of service. In this way I hope to make a clear enough comparison of the two systems to enable you to decide what the proper course is for us to pursue in finding the solution of this problem.

Many are perhaps unfamiliar with English transportation terms, so I will explain that "miscellaneous goods" is the English term for less-than-carload (l. c. l.) freight; "cartage" is substituted for trucking, "trader" for both consignee and consignor, "van" for horse-drawn vehicle and "carman" for driver or chauffeur. I will use the English terms in describing their methods as, in most cases, they make for both brevity and expressiveness.

Transportation-Problem Factors

I will not quote what the motor-truck interests say about this subject of railway cartage, but later will cite what some of the railroad executives have said, as examples of the importance the railroads attach to the problem. I wish to make it very clear that, in my opinion, the wasteful and chaotic methods of collecting and delivering the miscellaneous goods at the railway terminals in our cities is just as much the fault of the traders and the cartage companies as it is of the railways themselves. Unless all three agencies are willing to give and take and to cooperate in every sense of the word, existing conditions will never be remedied, but will go on getting worse until eventually it will result in seriously retarding the development and prosperity of the Country and this will come sooner than some may think.

In the first place, it certainly seems reasonable to say that the railroads and all other transport undertakings should be run on the same plan as any sound business undertaking. In other words, the transport companies should be permitted to earn a maximum return on their investment consistent with an efficient and economical transportation service. Referring to the railroads in particular, as they are the principal agencies concerned, it seems only fair to permit them to accumulate a surplus in good years to carry them over bad years. Every business enterprise is allowed to profit by the increased business in "fat" years and, through proper direction, be prepared to carry over during the "lean" years sufficient funds to fulfill the obligations any stable organization must have to retain the confidence and support of its shareholders and of the public. Surely, the railroads should be entitled to the same consideration, especially when they play such a vital part in the life of every country, particularly in this Country of ours where the distances are so great and adequate transportation facilities so necessary to our progress. Many will say that such policies are impossible, that they would endanger the whole business structure of the Country because there must be cheap transportation regardless of everything, and the only way to insure it is by keeping the "lid" on the railroads when it comes to making a profit by transporting the people and goods of the Country.

The best way to keep down the cost of everything we purchase is to reduce railroad freight-rates and, in passing, I ask whether the public benefits to anything like the same extent when the rates are reduced as it pays for the increased cost of goods when the rates are raised. My reply to such arguments is that, without sufficient funds, the railroads cannot furnish adequate, efficient and economical transportation service for this Country or any other. This is the condition of affairs we are now rapidly approaching; in the case of many railroads, we already have reached it.

It is a well-known fact that many of our railroads have been mismanaged in the past and, for this reason, much unwise regulation to control them has been brought about. Moreover, when we consider for instance that, according to President Loree of the Delaware and Hudson Railroad, in an average 14-day cycle for a freight car it moves only 1¼ days, it is apparent that the efficiency with which our railroads are operated leaves much to be desired. This is not a paper on railroad economics, but in order that we may take a broad outlook of the matter, we must first study it from all sides. I wish to point out some of the things the men in the automotive industry can do to help the railroads and by so doing, to help themselves as well; to work out a really efficient and economical transportation service that will enable the railroads and all other transport agencies to supply transportation facilities adequate to our needs, and at the same time make sufficient profit to attract the required capital to carry on with.

[1] M.S.A.E.—Consulting engineer, General Motors Corporation, New York City.

The greatest sources of waste in our present transportation system are, first, where the railway stops and cartage begins; and, second, in the short-haul field. Compare the rail charges on a consignment of l.c.l. freight with the average cost of collecting and delivering the freight at both ends. Even on those carload shipments where the goods must be carted at both ends, the cartage cost, due to delays at terminals congested with freight waiting to be cleared, and inefficient cartage methods, is usually greatly in excess of the rail charges; or, at least, the proportion of the cartage cost to the rail charges, distance considered, is entirely out of the realm of economy. Naturally, this condition has a disastrous effect on the railroads. Congested terminals mean that the equipment is tied up and the whole system is thrown out of gear all along the line. The extent to which this affects the business of the Country can be measured by the volume of traffic to be dealt with. If the traffic is heavy, the conditions we had in 1919 and 1920, of embargoes and terminals choked with traffic, will result. But even with normal traffic and no embargoes, the economic waste and delay costs enough in 1 year to make it more than worthwhile to grapple with the problem and solve it. We can solve it, once we realize two things; first, that there is such a problem and, second, that we can save money by finding a proper solution for it.

The best way of attacking this problem is, in my opinion, as follows: There are four major classes of goods to be transported commonly known as carload, less than carload, express and parcel post. The first can be eliminated for the moment. The remaining three, then, are the cause of most of our transportation waste, but especially the first of these. Here is where there is the greatest room for improvement, in the cartage of l.c.l. freight between the railway terminal and the store door. All are more or less familiar with the confusion and loss of effectiveness that result from the absolute lack of any systematic method of railway-terminal cartage. You also know that, due to the absence of scientific loading, routing and scheduling methods, it is common practice to have 5-ton motor-trucks leaving terminals and store doors with only a few hundred pounds of goods, not to mention the degree to which this sort of wasteful transportation prevails with smaller sizes of motor trucks and horse-drawn vehicles.

Aside from the need for reform in this particular field of transport alone, think of the economic waste involved in the transport of l. c. l., express and parcel-post traffic combined. Performing practically the same service, at least so far as deliveries at destination points are concerned, the result is that a trader frequently will have three different vehicles at his door; one, say with 1000 lb. of freight, another with 200 lb. of express, and a third with a 10-lb. parcel-post package, all three carted from the same terminal but in three separate partially loaded vehicles. There is nothing economical or efficient in such methods, and no reason for such waste and duplication of effort. The railroad side of this picture shows the same duplication of effort with a consequent waste of equipment prevailing. We have the freight car, the express car and the parcel-post mail-car, all going to the same place, when the contents of all three could be carried in the freight car alone at an enormous saving to the railroads in equipment and labor. In short, what we need to do is to get greater load-efficiency out of our transportation equipment, on both road and rail, and load to capacity. The only way to do this is through the coordination of all transportation agencies. Each must harmonize with the other.

We must acknowledge that the kind of transportation I have outlined is far from constituting harmony and coordination of effort. To haul goods 250 miles overnight by rail and take the same amount of time, or longer and usually at greater cost, to transport those goods from the railway terminal to the merchant's store door, 2 or 3 miles away, is a sad reflection on our business sense.

An executive of one of the largest railroads in this Country stated recently that between 400 and 500 cars could be released per day in one city alone if his railroad could get rid of the intra-city haul. Think what such a saving would mean to that railroad and to the merchants of the Country in one year alone; it would make more than 150,000 cars available per annum for other work. Another railway executive said that the use of the present equipment for our railroads would be increased threefold by the elimination of terminal waste.

With regard to the transportation problem we have to solve and the advantage of solving it, I will quote what two of our railroad executives say in reference to this matter. W. H. Lyford, vice-president of the Chicago & Eastern Illinois Railway Co., said in a paper delivered before the National Highway Conference at Washington, in October, 1922:

> The most important field for cooperation between the railway and the truck is offered by collection and delivery of l.c.l. freight in large cities.
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> Combined l.c.l. freight of all railways reaching a city could be collected and delivered by a properly equipped single trucking-organization, working in full cooperation with the railways, at less cost than is now paid by the traders in that city for their cartage, and still yield a valuable profit to the trucking organization.

Elisha Lee, vice-president of the Pennsylvania Railroad Co., said in his address on The Motor Truck and Our Railroads:[2]

> It seems to me that one of the most important opportunities for useful and successful coordination of motor and rail facilities may be expected to lie in organizing smooth-working freight pick-up and delivery motor services in the larger cities, for the less than carload traffic, to be operated in connection with inter-city hauls by rail. Such an arrangement would extend the scope of rail transportation by making it a really complete service from the premises of the shipper to the premises of the consignee. It would allot to each transportation agency employed the portion of the service which each is pre-eminently fitted to perform; to the truck the terminal work and to the railroad the line haul. This subject is of vital importance to the railroads, their patrons and the makers of motor vehicles, alike. If such a service could be worked out for the larger centers of the Country generally, it would constitute one of the most momentous advances ever made in the handling of railroad traffic, and create an economically sound market for the product of the motor-truck makers.
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> In approaching this question it may be noted that the tendency usually is to dwell largely upon the possibilities of reducing the cost of distribution through the establishment of such a system of store-door collection and delivery, in the sense of making possible a structure of through-rates which would be lower than the combination of the existing rail-rates and the present costs of collection and delivery at each end. It may be doubted whether that is really the best selling point upon which the automotive interests can focus attention, or whether it is actually capable of immediate realization. It must be remembered that to inaugurate

[2] See THE JOURNAL, February, 1923, p. 152.

such a service as we are talking about, it will be necessary to enlist the aid of considerable new capital. A service of the character contemplated would certainly be a vast improvement over the haphazard facilities for collection and delivery now usually at the disposal of shippers and consignees who do not have their own trucks. It would constitute a notable addition to the present service and should be worth a fair and reasonable price. It is difficult to see upon what other basis the needed capital can be attracted.

In convenience and speed such a service would lie midway between the present ordinary freight and the express. It would be substantially a semi-express service, affording complete through transportation, rendered by a combination of motor truck and freight train instead of by a combination of truck and passenger train. The aggregate charges would of necessity have to be adjusted in proper recognition of the character of the service, always bearing in mind that new capital must be attracted if trucks are to be purchased and operated. There would be many economies outside of the rates themselves. Among them may be enumerated the greater dependability of service; the reduction of losses in transit; lower insurance rates; greater ease in making shipping arrangements and paying bills; and a reduction in the time goods are on the way, which would amount to a saving of interest on idle capital. The shortening of the time in transit would also permit the carrying-on of business with smaller stocks, thus in another way reducing capital charges.

In other directions such a system of collection and delivery would effect many savings which, although difficult to measure exactly, would be nevertheless real. Among them may be mentioned the more efficient use of the public thoroughfares, lessening the losses and delays now incident to the street congestion and crowding that are so marked under the present totally unorganized trucking methods in general use.

Since my return from Europe, the picture I have got of this situation is that the railway men, whatever their record has been during the past, are now more than willing to cooperate with the traders and the public to work out some plan that will be satisfactory to everyone. Let us hope that our lawmakers will also cooperate and make it possible for the railways to furnish constructive assistance in this matter, unhampered by restrictive regulations. The foregoing shows that an efficient system for the collection and delivery of miscellaneous-goods traffic at railway terminals is of vital importance to the success of the railroads as well as to the traders and the public.

Delay and Excessive Cartage Cost

To show clearly what a large factor cartage is in the cost and the time of transporting miscellaneous goods in our large cities, I will relate an experience of my own. My home is in New York City and, having purchased two beds in Baltimore, I had them properly crated and shipped to me by freight. Five days after the beds were shipped, I received a notice from the railroad company that the beds were at the Harlem River Freight Station and that they must be removed within 48 hr. Upon telephoning the freight station, I was referred to a "reliable" truckman, who agreed to deliver the beds at my house. This he eventually did, but not within the time limit of 48 hr.; so, I was forced to pay 50 cents for storage charges, and the cartage charge on the two crates of 130 lb. each was $4. The freight charge from Baltimore to New York City, about 200 miles, was $2.13 and the cartage from the freight depot to my house, about 2¼ miles, was $4. When I protested both the cartage and the storage charge, the driver of the motor truck invited me to go and see what a difficult job it was to collect freight at that station.

After finding out the tonnage he moved per day, I am satisfied that, if there was to be a fair profit for his company, the charge made was not excessive. This cartage company is an organized company that has been in the business for some time, but from what I learned then and since the trouble is largely due to the general lack of system at such freight stations and in cartage methods, and this case is a typical example of the waste that prevails in this field of transport. The load efficiency of that cartage company's trucks, including return loads, was about 30 per cent.

The foregoing information should make us realize the necessity for our help and active participation in the accomplishment of something that will benefit all of us, whether we be traders, railway men or motor-truck operators, poets or farmers; and I will now relate some of the essential things about English-railway cartage-methods for the collection and delivery of miscellaneous-goods traffic, as I am convinced that their plan contains the principal elements of a system that perhaps would not be a "cure-all" for us, but would, at least, be a vast improvement over our present disorganized practice.

The English-Railway Cartage-System

The term miscellaneous goods is used by the English railways to cover the class of freight that we usually term l. c. l.; in other words, the freight composed of small consignments, not the carload or large shipments, the so-called "store-door delivery" variety which, in England, is composed of consignments of about 300 lb. or less each. The details of the cartage and station workings constitute such a complex subject that it is only possible to give an outline of the system at this time. Therefore, I will discuss the subject only under the two main headings of delivery and collection. The delivery of goods begins at the time the car door is opened, and ends at the time the cartage vehicle leaves the trader's door. The major steps between those two points are best divided as follows:

(1) Unloading and checking of goods from cars to platform or vans

(2) Barrowing of goods to van-loading sections or warehouse

(3) Loading and checking of goods onto cartage vehicles in district and street order

(4) Loaded vehicles removed from sheds, and either parked by van setters or removed by carmen; accompanied by a pass, over scales and out into town for delivery

The first step in item (1) is controlled by the checker, and his guide is the invoice of the contents of the car. The work of marking the invoices is a big subject, and one that cannot be thoroughly covered at this time. It is sufficient to explain that when the invoice reaches the checker at the car door, it contains the following information pertaining to the cartage side of each consignment: (*a*), whether traffic is "delivered," or on a "wait order"; (*b*), the name of the street; (*c*), the postal area, including the area number; (*d*), the locality; and (*e*), the district number or mark. Regarding the information shown on each invoice, it should be noted that the "district markers," the men who mark the invoices, must be accurate. Local knowledge and experience gained by constant repetition of company and street names enable the marking to proceed like clockwork; in fact, in course of time, the staff becomes independent of the street lists for the most part.

The checker furnished with the invoices duly marked, instructs the "barrower" to what point he is to take the packages, whether to a "delivered" berth or to a "wait-order" berth. The "barrower" in time becomes so familiar with this work of item (2) that he has only to be given the name of the consignee to know where the goods should be placed. Many of these men have been with the same railway all their lives, and a large part of the time on one particular job.

Item (3) constitutes one of the most important steps of all. The van loader has a "delivery sheet" for each consignment of goods. The delivery sheet is made out from the invoice, and is practically an exact copy of the entries on the invoice. The "single-entry delivery sheet" is used very generally by all English railways now and, as the name signifies, it deals with one consignment only. This document eventually becomes the railway company's receipt for the goods, and is the "Bible" of the carman or truck driver, because his delivery sheets cover all of the goods on his van; each sheet is charged to him when he leaves the station and must be accounted for before he checks off at night.

The van loader should possess the two important attributes of having a thorough knowledge of the traders and the streets and being skillful in stowing goods with the object of securing immunity from damage. The first qualification should insure that the goods are positioned so as to avoid any unnecessary travel on the delivery rounds and the overhauling of loads in the street en route; the second should obviate damage to the goods and also personal injury through street accidents.

We can consider that the van is now loaded and ready for the carman. The vans that are parked after being loaded need not be described at this time. The carman must first get his delivery sheets, and from them find out the number of his van. Carmen usually have the same horse or horses every day or the same motor truck, but may have any one of several hundred vans. As soon as the carman obtains his delivery sheets from the cartage office, he is off to his district to deliver the goods, after presenting his gate pass to the policeman at the gate.

The subject of districts is covered more in detail in describing the cartage-control system of the Midland Railway. It should be explained, however, that there can be no hard-and-fast rule as to the size and the shape of the districts. Thus, where the traffic ordinarily is sufficient for one vehicle per day only, a district carman will take a fairly large radius; on the other hand, where there are many firms in close proximity to one another, several districts may be comprised within a small compass. This means that exhaustive tests will be necessary to determine the most suitable divisions, and here is where the English postal-area map is so valuable in laying-out the districts. In most cases, the districts are based on collection stops, and the carman is given a load into his particular collection district.

In following the carman through, we find that he makes his deliveries in the order in which he can save the most time and travel the shortest distance, but all the time bearing in mind his collections that are to be made that day. He usually finishes one or more loads of deliveries by 12:00 noon and starts on his collection rounds after lunch.

It should be noted here that the bulk of the miscellaneous-goods traffic on English railways is delivered to the consignees before 12:00 noon every day, and it is common practice to give 24-hr. service for this traffic to places 200 miles distant, and often farther than that on certain classes of traffic. Think of it; the "Bradford traffic," woolen goods largely, is picked-up say before 5:00 p. m. today and is invariably delivered in the "Wood-Street Zone" in London by 9:30 a. m. tomorrow; and Bradford is 230 odd miles from London. This is not a special performance. The English trader expects and demands this kind of service, and the railway-goods agent has a complaint to deal with very quickly if the goods are late in arriving at the trader's store door. One may ask, how it is possible to give such service. It all hinges on the "eye-of-the-needle" link in the chain of transporting the goods; that is, the freight-station handling-and-cartage system. Every railway man and many of the prominent traders with whom I talked about this matter were emphatic in stating that the traffic could not be handled expeditiously if the traders did their own cartage. The stations would have to be double their present size and, even were that possible, it would be a very doubtful proposition.

The collection of the goods from the trader's, or consignor's, door can be divided into four operations, and are practically just the reverse of the delivery workings; (*a*) traffic carted into the station, accompanied by "consignment notes"; (*b*) van loads backed to shed platforms or cars; (*c*) the unloading of the van loads and the weighing of consignments; and (*d*) the barrowing of goods to the car side. The districts assigned to the regular "district carman," or "roundsman" as he is sometimes called, are based on the collection stops in a given area or district. Each district carman has a list of the regular stops in his district; some are daily, some every other day and the like. In addition, he may have several special calls to make within his district. Special or extra deliveries and collections are usually taken care of by "unattached" or "odd" carmen. Here is where the "cartage controller" comes into the picture.

Cartage-Control System

The Midland Railway has, in London, the most scientific cartage-control system of which I know. The essential features of the system are as follows: St. Pancras and Somers Town are the two main London goods stations of the Midland Railway. In addition, they also have several sub-stations with rail connections and some depots and receiving offices, neither of which have rail connections and are used largely to receive traffic from the traders located in this vicinity. This traffic is consolidated into loads for the main outwards goods-station, there to be loaded into cars and dispatched to the consignee. London is divided into what are known as postal areas, such as N. W. 1, E. C. 4, S. W. 1 and so on. This was done by the Post Office Department to expedite the delivery of mail, and this postal area or zone map is used by every railway and road-transport firm engaged in collection and delivery service in London. Using the postal-area map as a basis, the Midland Railway has divided London into ½-mile squares based on the collection stops required. Each carman is allotted a district covering one or more of these ½-mile squares; he receives a district number by which he is known, and all the various documents, delivery sheets and the like that he deals with bear his district number.

Taking the delivery of the goods from the goods station to the trader's door first, the written instructions to the loading staff are to follow the lists prepared for them showing the principal streets in each postal area, and giving the number of the district carman responsible for the collection of traffic in each street. So far as possible, the same carman performs both delivery and collection work in his particular area, but where this is

not possible to arrange, he delivers in some closely adjacent area, and the loaders must load the vans accordingly. It is a rule that the arrangements made must not be such as will prevent the district carmen from getting onto their collection work at the scheduled time. All the regular collection stops are made on a schedule-time plan. When a carman leaves with his first load of deliveries in the morning, he knows whether he is to return for another load, to report to the controller's office or to perform either his regular or some special work. In most cases, the district carmen report to their call office after finishing their deliveries. Each call office is supplied with schedules of the district carmen working in the vicinity. These schedules show all details of the carman's work, together with the streets and the houses covered by each. The following rules explain the method by which the cartage controller is kept informed as to the movements of all carmen:

(1) Any orders of a miscellaneous character received at a call office, either through post or by telephone, must be numbered with the district number and handed to the carman when he calls

(2) Full-load collection-orders received by the receiving offices and depots must be telephoned to the control office at Somers Town

(3) Orders received by the receiving offices and depots, subsequent to departure of the district carman, must be telephoned to the control office at Somers Town

(4) No alteration may be made in a district carman's scheduled work without obtaining sanction from the control office at Somers Town

(5) Any odd men arriving at a receiving office may be used for clearing the office, but for no other purpose without first communicating with the control office. The latter will anticipate the arrival of odd men, and endeavor to give instructions so as not to occasion delay

(6) Clerks in charge of call offices will be responsible for calling the attention of the controller to any district carman who fails to call at the office for instructions if he is scheduled to do so

From the foregoing it should be plain what a thorough knowledge the cartage controller has at all times of the movements of every vehicle under his control. It is through this system that an efficient and economical cartage service is maintained.

Before leaving this subject it should be mentioned that, through the information supplied to him, the cartage controller is not only able to operate the vehicles to the best advantage, but also is in a position to cater to the daily or even hourly requirements of the traders. One example will serve to illustrate this point clearly. Suppose the district carman in a certain area has orders to make a collection stop at a certain trader's premises every other day and, for some reason, the trader has a consignment to ship on the day the carman makes no call. The trader simply telephones the controller who, either by communicating with the proper call office or another trader on whom he is scheduled to call next that day, gets into touch with the carman. The result is that the carman is notified of the special call to be made and takes care of it, thereby giving prompt service to the trader at little or no extra cost to the railway. A case like this, without a proper control system, would mean either a special trip for a van or putting the trader off until the next day; and, if the traffic were competitive with another railway, the latter plan might cause the railway not only to lose the consignment in question but also to lose all of that trader's business in the future.

Another important function of the controller's office, from the railway point of view, is that of checking the tonnage carted from every trader. In this way the railway can keep a very close eye on the business of the traders who ship over its lines; and, if the traffic from a trader drops off without any apparent reason, an inspector calls on that trader at once. It may be that the service is unsatisfactory or that the carman has made trouble. In any case the matter is dealt with properly and, consequently, very little traffic is lost if the railway can possibly prevent it. Furthermore, by watching the tonnage carted per carman, it is possible for the railway to obtain between 60 and 75-per cent load-efficiency on all cartage vehicles, which is by far the best record I know of in this class of service. These instances show how necessary a controller plan is to the successful operation of a large cartage organization.

As soon as the district carman finishes his collections, he returns to his home station. When he enters the station his van is weighed and he is given a ticket on which the weight of his van and its load are shown separately. The next step is at the "scrutinizer's" box where the "consignment notes" are gone over and from them the "scrutinizer" knows where to send that particular load, so that the van will be berthed close to the car into which the bulk of the goods must be loaded, and so make the barrower's trip as short as possible. The carman then backs his van into the berth indicated by the "scrutinizer." The berth number is marked on the top sheet of the consignment notes. He turns his weight ticket and consignment notes over to the shed foreman, and this finishes his collection work, provided his consignment notes check with the goods on the van. To explain the nature of a "consignment note," single-entry type is the best. They are handed to the railway company with each consignment tendered for forwarding by rail, and should accompany the goods from the van to the car; immediately the goods are checked and loaded, they are passed to the invoicing office. The carman's next duty is to turn over his delivery sheets and any money he has collected from consignees to the cashier's office and obtain a receipt or clearance for both. Then, after putting his horse away, that day's work is over for him.

Following the van load of collected goods, the third operation is the unloading of the goods from the van and the weighing of the consignments. At each unloading berth, a staff is stationed, usually two but sometimes three gangs. Each gang consists of a checker and "caller-off," or unloader, with two or three barrow men. The van is now ready for unloading, and the checker has been supplied with the consignment notes for the load.

As an example, we will suppose "John Brown, Glasgow, 2 packages," is the first consignment dealt with. The packages are placed on a hand-truck by the unloader and the barrow-man is instructed where to take the goods. He also is given the consignment note covering these goods. In this case the two packages are for Glasgow and the barrow-man has been given the consignment note and instructed to take them to "No. 12 loading-up platform." The distance is not great, as the van has been positioned opposite. On arriving at No. 12 platform, he informs the staff working there that his packages are all for Glasgow, and he is instructed to place them in a car labeled as going to that place. The loading staff take the consignment note from him, pack his two packages in the car and insert the number of the vehicle in which loaded, on the consignment note. The goods are

now in the car, and the fourth and last operation is complete.

Although I have only been able to outline very briefly the methods used, I hope it is a sufficient explanation to present a picture of the essential features of English-railway cartage-practice. A paper could be written on each of the headings I have mentioned, and on many others not referred to in this paper. The subject is one that requires close study and as much light as can be brought to bear upon it, if we would know it thoroughly. It took me a large part of the 15 months I was abroad to learn what I know about it, but I feel that the time spent was justified, for I am convinced that many of the English-railway cartage-methods, especially the principal features of their cartage-control system, can be applied to great advantage in solving our railway cartage-problems if we are willing to learn.

The Field for the Motor Truck

The field for the motor truck lies in a properly coordinated, well organized collection-and-delivery service for the cartage, drayage, trucking, or whatever the term may be, of the miscellaneous-goods traffic of every railway terminal in every city of this Country. I am not mentioning the short-haul traffic now performed by the railways within a 25-mile radius of our cities, and which offers a tremendous field for organized motor haulage. Moreover, that the railways would be glad to let the motor trucks handle this traffic, is not a rash statement to make. Again quoting Vice-President Lee of the Pennsylvania System:[3]

> There is just one more subject upon which I would like to touch, and that is the limits of distance within which the motor truck, instead of acting jointly with the railroad, may be regarded as fitted to take-over merchandise freight service in its entirety. In my opinion, all freight service within city and highly developed suburban areas should be performed entirely by truck, except those special cases involving single pieces of such great weight as to necessitate the use of railroad equipment and roadbed. Otherwise, the railroads ought to be relieved altogether of intra-city business, so that their tracks within the municipal areas may be reserved entirely for the purposes for which they were constructed, namely, the rendering of the strictly terminal service required in connection with the line hauls.
>
> Outside of the strictly cosmopolitan districts, the question of determining the economic limits of truck operation resolves itself into one of determining the point at which the cheaper costs of truck service within terminal zones begin to be overcome by the greater efficiency of the line haul by the railroad. The distance would naturally differ for every center. It may sometime have to be designated, more or less arbitrarily, for every cosmopolitan district, by regulative authority. Possibly a fair average distance might be 25 miles around every large city. Within a circle of some such radius most of the less-than-carload work can be done more efficiently if performed entirely by trucks. Outside of it, the greater efficiency will be obtained by the use of trucks for collection or delivery, and the railroad for the intermediate line haul.

Therefore it should be unnecessary for anyone to need to point out the field for the motor truck in this Country for, in my opinion, the motor truck is on the eve of entering a field of activity that will make the transportation of people and things, from one part of the earth's surface to another, cheaper and easier than today appears to be possible of accomplishment. The opportunity awaits us and, if the transportation men of this Country fail to take advantage of it, we deserve to suffer the consequences. I am convinced of one thing; it is that to solve our transportation problem we must labor unceasingly, give and take, cooperate and grasp every opportunity we can to perfect ourselves. If we all of us, railway men, road-transport men, traders and the public, earnestly and honestly do these things, we are sure to succeed.

Horse Transport

I have a very soft spot in my heart for the horse, provided he is kept in the proper place and that is not where a mechanically propelled vehicle is cheaper and quicker. Anyone lacking even an elementary knowledge of transport who stops to observe the traffic congestion in our large cities can see that the horse vehicle is unsuitable for much of the work it now performs. The experienced observers know that, if loading and unloading were more efficiently handled and less subject to delay, the economic field for horse transport would be reduced beyond the conception of most people. Even as matters stand today, were accurate costs known, it would be found that the motor truck should replace a very large proportion of the horses used in the urban centers of not only this Country but those of other countries as well.

As an instance of what has happened in this matter abroad, according to J. H. Brodie, city engineer, at Liverpool, England, in 1919, along the line of docks, horse-drawn vehicles handled 98.4 per cent of the tonnage and mechanically propelled vehicles handled 1.6 per cent. In March, 1922, horse-drawn vehicles handled 52.4 per cent and the mechanically propelled vehicles 47.6 per cent. I assure you that an Englishman is hard to change; so, you may rest assured this Liverpool change is entirely warranted by the facts and figures. Moreover, the English horses are wonderfully strong, and 12 to 13 tons is a common load for two horses on the Liverpool docks.

The Unit Container

On the subject of the unit container as applied to traffic for interchange between the railway car and the road vehicle, I have discussed this subject at some length with both railway and road-transport men abroad as well as in America. My conclusions are that, without radical departure from present-day practice, it is only for special classes of traffic that the unit container can be used to great advantage.

Fig. 1 shows the Vickers duralumin unit-container of 3-ton capacity. Its unladen weight is only two-fifths that of an oak container of equal capacity. The containers shown in Fig. 1 have proved to be much more economical than any other type I know of. They are constructed of duralumin, a metal that is described at length by R. W. Daniels.[4] The technical editor of *World's Carriers*, London, Hugh Miller,[5] wrote about this container as follows:

> The Vickers duralumin sling-van has not as yet been made of sufficient size for the furniture removing or like business so far as we know. The one we saw, and which we illustrate, was about half the size of the furniture remover's sling-van, and is being used so far experimentally only, but we cannot conceive it as a failure. The actual weight is about two-fifths that of an oak van of equal capacity; that is, assuming the weight of an oak van as 1 ton, the duralumin van would weigh 8 cwt. only, and where the rate is 80

[3] See The Journal, February 1923, p. 154.
[4] See The Journal, December, 1922, p. 477.
[5] See *World's Carriers*, (London) Feb. 15, 1921.

shillings, or about $20 per ton for the goods transported, a quite usual rate for the class of goods carried in such vans between London and Liverpool, for instance, there is a direct saving of £2 8s, or approximately $12, without counting the freightage for the returned empty. Besides the advantage gained in the reduction of weight, the Dartford Engineering Co., the container manufacturer, claims a great reduction in the cost of maintenance, though of course, that has yet to be proved. The weather has no effect on duralumin and, with equal treatment, duralumin vans should outlast by a great many years those built of oak or other wood, though that also remains to be proved. The question of strength is, of course, of very great importance. If actually subjected to load-tests, duralumin vans would carry three times the loads of the wooden ones, but the main idea has been to combine lightness, strength and durability, the last two relating to its power to resist impact blows against railway trucks, ship hatchways and docksides. Vickers duralumin has a tensile-strength and hardness equal to good quality mild steel; it is not an easy metal to handle, and considerable experience in its heat-treatment is required. The cost, of course, is high, as that of the metal is also; but, as we have explained above, the

Fig. 1—A 3-Ton Unit Container That Is Built of Duralumin and Weighs when Unloaded, Only Three-Fifths as Much as a Wooden Container of Equal Weight

extra cost is soon accounted for by the saving in the cost of transport, and we anticipate that there will be a further compensation in the lower cost of maintenance. In the case of an industrial motor-vehicle body, the weight can be got down nearly three-fifths, thereby giving greater carrying capacity and attendant advantages.

In discussing these containers with Mr. Griffiths, the manager of motor vehicles for Lyons & Co., London, the first firm to use them, he told me that after 1 year's service the maintenance and repair cost was practically nothing, whereas the cost of repairs to their wooden containers was very high.

An English railway executive, the general manager of one system, sums up this whole subject of containers in a clear and concise way in a letter to me that reads as follows:

You asked me for an expression of opinion on the use of containers for goods traffic. My view is that in the course of time containers will be inevitable, because it is one of the few means of reducing goods terminal-costs. Their use implies that trade customs will have to alter and people will have to purchase in

Fig. 2—Transferring One of the "Demountable Flats" Used by the London & Southwestern Railway from the Motor Lorry to the "Stand" Lorry

larger quantities before such devices could be effectively used, and the railway companies might be persuaded to offer lower rates for traffic carried in containers and conveyed at the owner's risk. Apart from the great saving in handling goods which would follow the use of containers, there should be a diminution in pilfering, or thievery, and a considerable saving to senders through not having to provide individual packing. Take, for example, hosiery, boots, cloth and the like. Suitably designed receptacles could be loaded by the senders and sealed. I am afraid that a lot of water will have to flow under the bridge before we see containers in general use, because, as you know, great events move slowly and, due to the present attitude of the public toward the railway companies and carriers generally, transportation agencies probably would be expected to provide all the necessary receptacles at their own cost and pass the benefit on to the traders. As you will appreciate, the cost would be very heavy; because, not only would containers of a suitable size have to be designed sufficiently strong to resist reasonable wear-and-tear and yet be light enough to make them mobile, but the railway vehicles would have to be redesigned in order to get a paying load, and road vehicles similarly would have to be made of such a size as would conveniently accommodate one or more containers. In other words, some measure of standardization would have to be aimed at, and both containers on the one hand and railway and road vehicles on the other would have to be made to fit each other economically.

Fig. 3—The "Flat" in Position on the "Stand" Lorry Ready for Another Load

Fig. 4—The "Stand" Lorry with the Loaded "Flat" Ready for Transfer to the Motor Lorry

An analysis of this railway man's statement shows that, before the unit-container system can be used generally in transportation, the traders must be willing to bear their share of the cost of developing it because they will benefit by it far more than the transport interests. Therefore, an earnest cooperation of the give-and-take variety between the traders and the carriers of freight is absolutely essential if the use of unit containers is ever to get beyond the experimental stage, in which it stands today. This whole picture is made up of three major parts: namely, the container, the motor truck and the railway car. To obtain the most efficient freight transportation, each one is dependent on the other.

Demountable "Flats" or Bodies

Before going to the subject of tonnage handled, cartage costs, and evidence showing that the English traders prefer their railway collection and delivery methods to ours, I will describe a "demountable-flat" device that is being used with considerable success on some of the English railways. Fig. 2 shows a London & South Western Railway "demountable flat" being transferred from a motor lorry to a "stand" lorry. In Fig. 3, the flat is in position on the stand lorry ready for another load. Fig. 4 shows the stand lorry with a loaded flat ready for transfer to a motor lorry. In Fig. 5, the loaded flat is being locked into place on the motor lorry by the driver. Fig. 6 illustrates the transferring of a loaded flat from a stand lorry to a motor lorry; two men transfer a loaded 4-ton flat with ease.

Fig. 5—The Loaded "Flat" Being Locked into Place on the Motor Lorry by the Driver

The London & South Western Railway, through the use of "flats," increased the tonnage moved per day per motor truck almost 40 per cent within 6 months and, although the system is only practicable under certain conditions, the same idea, possibly in a little different form in certain cases, could be used to good advantage in this Country.

Cartage Costs and Tonnage Hauled

In 1919, the latest year for which complete figures are available, the annual tonnage of miscellaneous goods carted by the London railway companies was 4,577,100 gross tons. The distance each ton was carted was from 1.78 miles on the Great Eastern Railway to 4.08 miles on the Great Central; the average for all railways in London was 2.46 miles. The average cartage cost per ton in September, 1922, for one of the largest railways in London was approximately $1.80 per ton; at Sheffield,

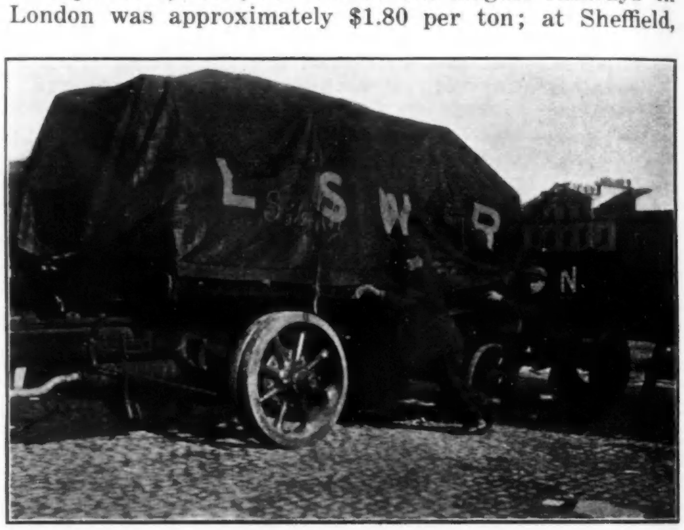

Fig. 6—Transferring a Loaded "Flat" from the "Stand" Lorry to the Motor Lorry

The Transfer of a Loaded 4-Ton "Flat" Is Easily Accomplished by 2 Men

for the same railway, the figure was approximately $1.25 per ton. So far as I know, we have no reliable figures available that it would be fair to compare to those given above; but let us imagine for illustration that, in New York City, a 5-ton truck at $30 per day can take two loads of 5 tons each from a railway terminal in an 8-hr. day. The cost to the trader then would be $3 per ton. Of course, if the truck handled five loads per day, but with only the same aggregate tonnage, the cost per ton would remain the same. Under ordinary conditions pertaining to this class of traffic, this is a fairly accurate picture of our cartage costs in railway-terminal service in large cities.

Unified Control of Cartage

The best solution of the problem we are discussing probably will be found by organizing either one national system for the whole Country or else one system in each of our large cities. That is the weak spot in the London cartage arrangements, but their transportation men know it, as will be seen from the following statement on the subject by the prominent railway official previously quoted.

> I have given much thought during the last 6 years to the London cartage arrangements. It is my opinion that, if provision has to be made for increased traffic

at a minimum of expense, the only way that this can be accomplished is to get to the source of the difficulty by organizing the receipt and despatch of traffic at the trader's premises properly, and systematically controlling conveyance through the London streets, as an effective organization of this character cannot be established until the railway cartage arrangements are controlled by one authority and an operating policy applied which will be common to all.

Opinions Regarding the English System

The opinions of several of the English trade organizations as to whether their railway collection and delivery service is satisfactory to the trader are quoted herewith. I should first explain that the American system of letting the traders do their own cartage is known in England as the "S to S," meaning station-to-station system; the "C & D" system refers to collection and delivery. Included in the list of associations approached by me regarding the matter are the Federated Associations of Boot and Shoe Manufacturers of Great Britain and Ireland, Papermakers Association of Great Britain and Ireland, National Association of Biscuit Manufacturers of Great Britain, Association of British Chemical Manufacturers, British Food Manufacturers Federation, Silk Association of Great Britain and Ireland, Inc., and the Leicester Chamber of Commerce.

Opinions such as the following, are expressed:

> This Federation prefers the system of delivery to destination to that of carrying "S to S" only.
>
> We do not consider that it would be an advantage to the trading community for the railroad companies to discontinue collecting and delivering goods. It would, in our opinion, not be so satisfactory to the traders as the present system.
>
> The attitude of this association to the questions you raise is that it considers the English system whereby the railway companies have power to collect and deliver merchandise by horse-drawn or mechanically propelled vehicles is greatly to the advantage of the trader.
>
> It would, so far as this country is concerned, be physically impossible for each trader to perform the collection and delivery of his own traffic, especially in the large towns, as it would lead to congestion and consequent delays to the traders' vehicles at the railway stations. Moreover, it would result in the railway companies' not being able to send goods delivered the same day as received at their stations.
>
> Outside of one or two of the larger firms in this industry, there are very few which have their own motors or cartage facilities, and it is largely to the advantage of the trade generally that the cartage should be in the hands of the railways as a convenience to them.
>
> The present system of cartage of goods to and from railway stations by the railway companies is entirely satisfactory. The greatest drawback to cartage by traders is the varying time of arrival of goods-trains, which means the keeping of vehicles especially for the purpose of fetching such goods at practically a moment's notice: whereas, the railway companies deliver promptly immediately on arrival. Moreover, the railway system of collection is better than could be arranged by private firms which, in many cases, would have to make special journeys for the sake of a single article.

In conclusion I ask everyone who can do so to read and ponder what Vice-President T. C. Powell of the Erie Railroad Co. said in closing an address to the Men's Club of East Orange, N. J., in 1922. He said:

> The important thing is the total cost of marketing, and marketing is made up of many items. In some instances and on some commodities the smallest item is that of transportation, but whether the transportation cost is a large or small proportion of the total cost of marketing, it seems to me without question that the greatest economy in transportation can be brought about only by a correlation of the various facilities for transportation. Instead of setting up ruinous competition and expending extravagant sums for disconnected facilities, capital will be conserved, waste will be eliminated and economies will be put into effect that will result in benefit to both producer and the consumer if we will sit down in sober earnest, outline a national policy of transportation and then work to that common end with the same spirit and consistency that in an army actuates "horse, foot and artillery" when struggling to achieve a victory.

IMPROVED STORAGE-BATTERY CONSTRUCTION

The paper by Clarence W. Hazelett published in the October, 1922, issue of The Journal entitled the Storage Battery as a Mechanical Problem was presented nearly 2 years ago before the Cleveland Section of the Society. In view of the fact that some difficulties were encountered and improvements made in the interim, it may be interesting to report them here.

The original construction involved the use of a wood-fiber separator that entirely filled the space between the plates. This construction did what was claimed for it, but in addition did some unfavorable things, under certain conditions. It was found that, although the excess gas escaped on charging, a certain amount of gas was trapped in the pores of the separator or in the very small space between the plate and the separator. This film of gas increased the internal resistance, causing the cell to heat seriously, particularly near the top of the plates, where the greatest amount of gas was trapped. As heat is the most serious enemy of grids, active material and separators, considerable trouble resulted under the conditions of service where the overcharging was considerable, i.e., where the charging rate was too high or a large amount of driving was done for the use made of the lights and the starter. On the other hand, under normal charging conditions the results have been splendid.

To make a product satisfactory under all conditions, it was found imperative to return to the grooved wood separator. This change was made a year and a half ago, while the use of a much larger number of thinner plates was of course continued. Experience shows that a large number of thin plates is far superior to a smaller number of thick plates, in both performance and life. The continued trend toward thinner plates by other large manufacturers is a result of this fact. It is to be noted that, other things being equal, thin-plate batteries are always more expensive than the thick-plate ones, either in vehicle or starting batteries.

The real practical advantage of the thin plates may be summed up as follows: (*a*) better starting performance, particularly with stiff engines; (*b*) much less tendency to buckle and inability to do damage when buckled; and (*c*) the positive decrease of shedding. The last point has been a surprise to us, but it is a well-known fact that other thin plates very seldom fail through shedding of the material. The failing point in thin-plate batteries is the final disintegration of the grid, normally the longest-lived part of a battery.

The fiber separator is still used as a temporary separator in shipping charged elements. On receiving these elements the service-station removes the fiber separators and replaces them with the grooved cypress separators furnished for that purpose. The advantages of this system in saving time were set forth in the previous article.

What Is Right with the Motor Truck Industry

By STEPHEN G. THOMPSON[1] CLEVELAND AUTOMOTIVE TRANSPORTATION MEETING PAPER

THE author doubts the wisdom of published questions accredited to a prominent editor who asks: "What is wrong with the truck industry?" since this wording blazons an inference that something is wrong and fosters a belief that motor trucks cannot be sold and operated at a profit and the facts marshalled by the author indicate that actual conditions are directly to the contrary. He believes that the broadcasting of a question that indicates the motor-truck industry to be unsound is dangerous as well as untrue, and quotes statistics of production and usage as compared with those of passenger cars to prove his contention.

The history of the motor truck is reviewed briefly and the great changes in conditions of transportation demand are stated as conclusive proof that the motor truck is a permanent asset, that there is nothing fundamentally wrong with the motor-truck industry and that, to the contrary, the motor-truck industry is fundamentally *right*.

IN an interesting article on motor-truck development, written by David Beecroft, he asks: "What is wrong with the truck industry? * * * Why is it that this machine cannot be sold at a profit and operated at a profit?" The position and influence of the publications of which Mr. Beecroft is a director merit recognition, particularly when he projects the serious charges and implications that his questions convey and that, if true, would spell the end of the motor-truck industry. If a thing cannot be sold and operated at a profit, it would soon destroy its own market, for no rational person would invest in machinery that it would not pay to operate, nor would the producer continue to manufacture at a loss. The facts in the case are that the purchasers are continuing to buy, and the makers are continuing to produce motor trucks. The established companies are overwhelmed with orders and the demand exceeds the present rate of supply.

The motor-truck industry is comparatively young, and it is going through the "growing pains" that all industry experiences in its development. Unfortunately, the motor-truck industry is so closely allied to the passenger-car industry that the recent astonishing growth of the latter has overshadowed developments in the former, and we are inclined to judge from the comparative aspects of the two industries as they appear today. This error has led to the general belief that the motor truck is not progressing, and even bankers have asked the same question that Mr. Beecroft put forth in his article: "What is wrong with the motor-truck industry?" When such questions emanate from important sources, we are apt to accept the implications without investigation, and to support our opinions by relating individual cases of failure with which we are familiar. While this is a very natural thing to do, it often leads to gross error. When this error is made by one whose influence is strongly felt the consequences are likely to prove serious.

I am not finding fault with Mr. Beecroft's viewpoint as a whole. Unfortunately, the form in which the article is printed blazons the words, "What is wrong with the motor-truck industry?" and the arrangement emphasizes the belief that motor trucks cannot be sold and operated at a profit. The casual reader is very apt to draw his conclusions from the headlines without digesting the text. Newspapers have capitalized this fact for years. Startling statements and innuendoes have been the life of newspaper circulation. It is the blazoned headline that I am criticising, not the text of the article, which is constructive. I would not for a moment belittle the good work Mr. Beecroft has done toward the development of the automotive industry. However, I cannot but believe that his viewpoint, as indicated by the headline, specified, is based on the current opinion that something is wrong with the motor-truck industry because it did not react as rapidly as did the passenger-car industry after the recent business depression. The reason I am discussing the matter at all is that I believe that the broadcasting of a question which intimates that the motor-truck industry is unsound, is not only dangerous, but is contrary to the facts. In support of this belief, I present the following comparative analysis of the passenger-car and motor-truck industries.

This analysis presents the history of the development of the motor-truck industry and compares that history with the development of the passenger car. Our conclusions, from the facts thus presented, will show that there is nothing wrong with the motor-truck industry; that its progress has been as rapid as has that of the passenger car, and that its product has surpassed the passenger-car product in durability and service. For the purpose of our analysis we will take figures published by the National Automobile Chamber of Commerce. These disclose the following pertinent facts:

STATISTICAL DATA

In 1909 the motor-truck industry had grown to the point where the total production for that year was approximately 3250 machines. The following 13 years showed a growth in the industry to a point where there were registered 1,330,000 motor trucks. This 1,330,000 motor trucks, registered in 1922, represents the sum total of the manufacturing effort of the motor-truck industry from its insignificant production of 3250 trucks in 1909 to its production of 240,000 in 1922.

Comparing this record with that of the passenger-car business, in 1899 the passenger-car industry had reached the point of production approximating that which is shown for the motor-truck industry in 1909. The records show this to be 3700 passenger cars. In 1912, 13 years later, the passenger-car registration in the United States was 1,033,000 machines. This 1,033,000 machines registered was the net result of the first 13 years of manufacturing in the passenger-car industry from the time when its production had reached 3700 cars. Compare this with the 1,330,000 machines as a record for the motor-truck industry in the first 13 years following the time when its production had reached 3250 cars, and we

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find that not only is there nothing wrong with the motor-truck industry, but that it outstripped the passenger-car industry by about 30 per cent in its net result in total registration. Today, the difference between the passenger-car industry and the motor-truck industry is merely a difference of 10 years in age, not a difference in the fundamental values of the two products. Certainly, one would not expect as much from a boy 13 years old as from a young man 23 years old.

The astonishing history of the development of the passenger-car since 1913 is now common knowledge. Whether or not the motor-truck industry is destined to repeat that history is a matter of conjecture. It is apparent, however, that the market is more restricted in its gross consumption than the market of the passenger car has been, for the reason that fewer people have a use for motor trucks than for the passenger vehicle.

Motor-Truck Sales and Operation Profits

When Mr. Beecroft asks, "Why is it that the motor truck cannot be sold at a profit?" he loses sight of the growth of the manufacturing institutions of the motor-truck industry and of the financial statements of those motor-truck companies who have directed their attention to the production and sale of the motor truck in its entirety as a transportation unit, rather than to promotion and financial manipulation. Also, when he asks, "Why is it that motor trucks cannot be operated at a profit?" he loses sight of the vast investments made individually and collectively by motor-truck operators. These investments, in many cases running into millions of dollars, stand as a testimonial to the record of economy and reliability of motor trucks in the service of the purchasers. When he says that motor vehicles cannot be operated at a profit, he ignores the growth of motor-truck fleets, in many cases amounting today to several hundred and, in some cases, more than 1000 machines. When he says motor trucks cannot be operated at a profit, he ignores the record of performance of motor trucks in service which have run from 100,000 to 500,000 miles and more and are still rendering efficient and economical service.

"The world counts the hits, not the misses," and the record of development of the motor-truck industry and of motor-truck operation is one of repeated "hits" so far as the industry is concerned. The "misses" have, in a large measure, been on the part of those purchasers whose selection of equipment has been made without due regard to the stability of the organization behind the truck; to the record of performance in service; to the manufacturing, sales and service organization; and to the reputation and responsibility of the manufacturer in the motor-truck field.

Development History

The history of the development of the motor truck is a history of progress. It is a record of transition in methods of transportation. The success of the motor-truck industry stands as a monument to the original perception of the early crusaders in the industry who were farseeing enough to be convinced of the eventual success of the machine as a necessity; plucky enough to venture enormous investments and patient enough to withstand the exasperating trials of development over a long period of time. The human mind is not prone to change from one method to another. This attitude undoubtedly is of benefit in society in preventing the enormous losses that might result from instantaneous or hysterical transition from one practice to another. Unfortunately, it often operates to retard progress unduly, long after changes have been demonstrated to be of advantage to the world at large. We have seen this demonstrated in the application of the telephone, telegraph, typewriter, adding machine, electric light, trolley car and many other commercial utilities.

The motor truck has encountered and conquered this eternal barrier, and, to its credit, it can be said that, in conquering, the battle was won solely because of the economic value of motor-truck transportation. Unlike the passenger car, the motor truck has no popular appeal to fancy. It is not influenced by personal vanity or pride. There is no "living up to the neighbors." The motor truck is an essential thing in the world of business today; it is an essential because it is in keeping with our industrial progress. Motor-truck operation marks a forward step in transportation. It is a natural consequence of the development and expansion of railroads.

The Changing Aspect of Transportation.

Railroad development permitted the concentration of manufacturing industries on a large scale at points convenient to their raw materials or for the distribution of finished products. It opened vast uninhabited regions to immigration and prosperity. By bringing the products of distant regions to the toiling millions of the cities, the railroads have made it possible for cities to increase in population and prosperity, and the entire civilized race has been blessed by the greater economic efficiency thereby obtained. This centralization of population in towns and cities created problems of transportation which seriously threatened further development of the communities. The frontiers of the cities pushed farther and farther into the surrounding country. Distances within the populated areas became greater. There was an increasing demand for food in larger quantities. This demand naturally stimulated the development of food-producing areas adjacent to these consuming centers. As the cities grew, these producing areas not only moved farther and farther away, but they also expanded to meet the demand for an increased production caused by the increased population. This development, like the proverbial flea on the flea, proceeds ad infinitum. Consequently, gardeners and dairy farmers who, a few years ago, were faced with a short haul to the nearby market, now find the horse-drawn vehicle of other days entirely inadequate to cover the increased distance to the cities where they dispose of their products. In the same way, the delivery areas of the city merchant and of manufacturing industry have all expanded with the changing conditions of our political economy.

The changes wrought by the centralization of industry have resulted in a disturbing disproportion of population in the rural and urban communities. In 1880, the population in the rural sections was 70 per cent of the total. Today the conditions are reversed, and 70 per cent of the people now live in cities; they produce manufactured products and depend on the other 30 per cent for their food supply. In the transition, the complexity and aspect of transportation is constantly changing. What was adequate transportation a few years ago is entirely inadequate today.

Increasing problems of traffic congestion have claimed the attention of railroad operators and engineers for the past 10 years and, at times, congestion has become so acute as greatly to impede freight-traffic movement. An entirely new phase in transportation has developed. The proposition is constantly before us. We see it on every hand. Compare the conditions of living in the city with those of the small rural community, and the facts in the

case are very apparent. The problems are insignificant in the small towns, but the complexity increases in the city and with the growth in the population. Nationally, the interchange of commodities and the interrelation and common interest existing between the communities, the states and the nation, constantly multiply the complexity of transportation. The development of the telephone, the telegraph, the postal service, the passenger automobile and the railroad have all contributed to ease of communication and dispelled isolation. This has created a demand for rapid and economic distribution of freight and passengers beyond the ability of the railroad and horse-drawn wagon to supply.

Motor Trucks Are Permanent Assets

The motor truck has established itself in this field; it is the connecting link between the wholesaler and the retailer. Today, transportation is divided between the wholesale user, and what might be termed the retail user. Bulk and low-rate freight is transported from the producing to the distributing centers, where it is reshipped to the retail consumers. These retailers market miscellaneous products at home and in the nearby cities, either directly to the consumer or through wholesalers, packers or jobbers. For the former class of service the railroads offer adequate transportation facilities, especially for the longer distances between the point of production and the market. For the latter, this form of transportation is available in but a limited degree, for it is obvious that the ramifications of the railroads cannot be expanded to the form of a series of spider's webs radiating from industrial centers and reaching all communities.

So, the motor truck has come to be a necessity; first, because of its value as an economical and efficient means of transportation; second, because the increasing complexity of our modern civilization has developed a demand for a new and better expansion in transportation that can adapt itself to changing conditions and that is, in large measure, unrestricted in its direction of operation. This demand not only applies to the freight-carrying vehicle, but to the motorbus as well. When properly correlated with steam and electric-railway systems, motor-vehicle operation insures the public convenient and economical transportation. It destroys nothing that progress has constructed, but rather increases the efficiency of those institutions.

Today, the motor truck constitutes our primary transportation system, delivering direct to the consumer or to the steam and electric railways for long-distance hauling. Its worth lies in *the value of the service rendered*, and it is in recognition of this value that Mr. Beecroft reiterates the conviction that the commercial vehicle is ushering in a new era of motor transportation. It is in recognition of this value that the fleet owner purchases motor trucks as a new factor in transportation capable of expanding his business zone; improving the character of his distribution and influencing the volume of his business by creating a constantly widening market.

The "Right" of the Motor Truck

This is the story of the history of the motor-truck industry. It is the story of the reason for the development of the motor-truck industry, and it is the story of the value of motor-truck operation. This story is the answer to the question, "What is wrong with the motor-truck industry?" The story tells what is *right* with the motor-truck industry. The "right" of the motor-truck industry is that it is based on the application of machinery methods to highway transportation. The application of machinery methods has resulted in mass production and improvement in all industry. It has created economy in cost. As a machinery-using nation, the United States has outstripped the world. If we make our goods by machinery, transmit our messages by machinery, write our letters by machinery, and do our arithmetic by machinery, and if, as an industrial nation, we have progressed through the use of machinery, it is logical that our highway transportation should be by machinery. Therefore, the motor-truck industry is fundamentally right.

I feel the industry owes a debt of gratitude to Mr. Beecroft. He has asked pertinent questions that have been uppermost in the minds of many. In this he has performed a valuable service; for, through his action, we are given this opportunity to tell the real story of the development and stability of the motor-truck industry.

TESTING ROAD PERFORMANCE

THE driving characteristics of popular cars, chiefly British, but including also some well-known American makes, are being discussed in a series of articles appearing in *Autocar*, London. The observations necessary for comparing the performance of the different cars are made during a test run over a standard route.

One of the standard test-routes is an 80-mile loop starting and ending in London and extending to the southwest for a distance of over 30 miles. It will be noticed that the first and last stretches entail traffic work. Incidentally, Putney Hill, just outside of London, provides an interesting comparative test owing to the fact that it must be taken from a crawl because of traffic conditions. Twenty miles out of London, the route includes the Brooklands race-track, where a special schedule furnishes most of the numerical data for the performance tests. Thus, the weight of the car and passengers, the time for a mile at full-open-throttle, the acceleration figures, the hill-climbing power and the brake performance are all determined at Brooklands. Before leaving Brooklands, an exact ½ gal. of gasoline is measured out for the drive from Brooklands to Newlands Corner. This stretch of road constitutes a fair sample of main-road, by-road and uphill work and is covered at a normal average speed with no coasting and no variation of carbureter setting, so that twice the speedometer reading, when the ½ gal. of gasoline has been consumed, should give a fair figure for the average miles per gallon.

The rest of the route offers opportunities for testing the suspension system, the steering properties, the engine vibration, the road-holding qualities and the hill-climbing characteristics of the car. In fact, with the exception of durability and upkeep, practically all features that affect the relative merits of a car may be judged on the standard test-route by a competent observer who has handled 100 or more cars over the same route.

This represents an ambitious though rather non-technical attempt on the part of the above-named journal to secure some reasonably reliable information and is a distinct advance over most attempts of this kind. An attempt is made to get real measurements of weight, maximum speed-acceleration, reserve power on hills and brake performance, in addition to the observation of general performance of the cars on standard test-routes that have been carefully selected to give average road conditions.

Discussion of Papers at the Annual Meeting

THE discussion of the papers presented at the recent Annual Meeting of the Society included written contributions submitted by members who were unable to be present and the remarks made at the meeting. In every case an effort has been made to have the authors of the several papers reply to the discussion, both oral and written, and these comments, where received, are included in the discussions. For the convenience of the members, a brief abstract of each paper precedes the discussion, with a reference to the issue of THE JOURNAL in which the paper appeared, so that members who desire to refer to the complete text as originally printed and the illustrations that appeared in connection therewith can do so with a minimum of effort.

In addition to the discussion printed in the April issue of THE JOURNAL and that given below the discussions of the two papers presented at the Engine Cooling Session, Aircraft-Engine Practice as Applied to Air-Cooled Passenger-Car Engines, by S. D. Heron, and Cooling Capacity of Automobile Radiators, by E. H. Lockwood, will, it is expected, be published in the June issue of THE JOURNAL.

TESTING LEATHER SUBSTITUTES AND TOP MATERIALS

BY J. B. DAVIS

ALTHOUGH waterproof protective material has been in use for many centuries, particularly in the Far East, its manufacture in this Country was not begun until about 1850, and not until the arrival of the motor car did the demand for so-called leather-cloth cause its production to take a jump. This demand has increased until in 1922 the record-breaking quantity of 50,000,000 sq. yd. was consumed. The growing popularity of closed bodies has produced a corresponding call for leather-cloth and the importance of classifying and of embodying standard tests in the specifications for it is receiving close attention.

With the view to assisting in the establishment of uniform tests for the various qualities that are desirable in high-grade leather-cloth, the tests in use by one of the largest manufacturers are described, and suggested specifications for top material, upholstery and special body leather are given. Particular requirements will determine the desirability of muslin, drill, twill, sateen, moleskin or duck, and the suitability of each is judged by the weave, construction, thread-count, weight and the like. Among the qualities that can be determined by tests, directions for which are given, are resistance to wear; tensile strength; bonding-strength; resistance to stretch and puncture; thickness; toughness and adhesion of coating; resistance to water, shrinkage, fire and heat; cleansability and resistance to gasoline and the effect of aging. [Printed in the March, 1923, issue of THE JOURNAL.]

THE DISCUSSION

G. W. KERR:—When I was endeavoring to select the strongest material, the statement was made to me by a salesman that all fabrics having the same structure, weight and thread-count have the same tensile-strength. A manufacturer said that this was not true. What have your tests shown in that direction?

J. B. DAVIS:—The original fabric has a certain tensile-strength depending upon its construction and weight. The tensile-strength is increased when certain strong coatings that intermingle with the fibers of the yarn and help to hold them together are applied to the fabric. Coated materials have a higher tensile-strength than uncoated materials, and some manufacturers bond two fabrics together. The bonding process gives, without excessive weight, the advantages of the tensile-strengths of both fabrics plus that of the bonding cement.

MR. KERR:—Is there not a great difference in the strength of the yarns from which the stuff is woven, so that there is a difference in the tensile-strength of materials otherwise the same; that is, having the same structure, weight and thread-count?

MR. DAVIS:—Generally speaking, that is true. There is the length of staple to be considered, the amount of twist and all the things that particularly concern the fabric manufacturer. It is not possible, just by taking the weight and making the thread-count, to compare the tensile-strength of two materials.

H. C. MOUGEY:—My understanding of these tests is that they were made almost entirely on new material. In the curves you show that some material, when new, may start out with a wonderfully good test, yet in a short time the order may be entirely reversed. Is there any way to test new material to find out how it will stand up later?

MR. DAVIS:—The mercury-arc light reproduces, as nearly as possible, the actnic rays of sunlight. By arranging the equipment to combine the action of water, wind and sun in a cabinet, you can ascertain within a comparatively few days how the material will stand up as compared with the old method that required from 6 months to 1 year.

MR. MOUGEY:—These tests were made on new material and you saw later how they compared on the exposure?

MR. DAVIS:—That is correct.

C. M. MANLY:—This paper parallels and goes beyond, to a considerable extent, the tests that we made on airplane cloth during the war, on both the coated and the uncoated fabric, especially in developing the ultra-violet tests and in the manner of carrying them out. Some of the rubbing tests have been extended very much over the crude ones we had to make. It seems to me that these

tests should be of great interest to the automotive engineer in drawing up specifications and in knowing exactly what materials he is getting, so that he can stand back of the product in the same way that he stands back of the other parts of the car through having drawn up proper specifications for them.

We had considerable experience in determining the strength of airplane material by thread-count. Of course, you can get any kind of results you desire, for they depend entirely on the quality of the cotton, or linen, or whatever it may be, out of which the yarn is made. All the airplane cotton cloth that finally was used was made from long-staple cotton; there was a great difference between the strength of that cloth and of the cloth made from short-staple cotton. The twisting and the mercerizing of it and the different chemical treatments it went through differed greatly in their effects. If you wish to go into the effect of the number of twists, you will find that the shortest route is to subject the material to the tests rather than to go into the intricate matter of the weave and the method of the chemical-processing of the cotton through the mills. We found that we could tell quickly whether the cloth was suitable for airplane covering, if we were given samples of the cloth, but at the beginning it was hard to get information from the cloth manufacturers as to the processes through which they put the cloth. There seemed to be considerable information on that subject that they did not care to disclose.

CHEAPER CLOSED-BODY CONSTRUCTION

BY GEORGE J. MERCER

THE author quotes statistics relating to the proportion of closed to open bodies and outlines the changes that have taken place in body construction in recent years. He sketches the advances that have been made and states that the question to be answered now relates to what all this improvement in manufacturing methods has accomplished toward reducing the price of a closed-car body to the consumer. He compares the percentage of public benefit in 1922 with that of 1914, excluding the period of inflated prices immediately following the war, and states that it is 10 to 15 per cent, but says also that this is an unfair comparison because of the excessive increases in the cost of labor, lumber, sheet steel and trimming cloth.

An unconventional type of body, covered entirely with fabric over a foundation of wire-mesh and buckram fastened to the conventional wood-framing, is illustrated and described in detail, together with a statement of its advantages. [Printed in the February, 1923, issue of THE JOURNAL.]

THE DISCUSSION

E. W. M BAILEY:—This construction possesses some very attractive features. How does the forming of the wire backing, the wire support for the fabric, lend itself to wide change of shape, full-sweeps and the like?

GEORGE J. MERCER:—The body-framing is conventional. The wire is put on and a thin layer of wadding is put between the wire and the buckram, which is three-ply, a scant ⅛ in. thick; after being fastened on, the whole is covered with shellac. That is the only foundation for the body panel that we use. We were surprised to see the stiffness and rigidity that we got from making the body in that manner. The forming of the wire on this body was done entirely by hand. When starting the work, the mechanic told me that he would do the upper round-back corner first, because he thought that was the most difficult part. It was formed so easily, however, that he was surprised. He had no trouble at all. The doors and other parts that are nearly flat take their shapes very easily. The wire gave very little trouble. The buckram was a little more difficult to handle. On the upper round-back corner, we cut the buckram and shaped it as we should shape the cover of a baseball, but we believe that it would be better to soften it, put it over a form, let it dry and then put it on, because the edges that had been cut came through. We had some trouble and had to shave the edges off and pad them a little.

MR. BAILEY:—As I understand it, you wrap this wire round and shape it over the form?

MR. MERCER:—No, we formed the wire first in the same way that a metal panel is formed. We anticipated that we might have to put it under the hammer, but we found that we could shape it by hand by bending it over the shape that we required. We found that we could get the required shape and then see whether it was right. We could flatten it or draw it out after it had been applied.

MR. BAILEY:—In mass production, would you require a form?

MR. MERCER:—Yes.

CHAIRMAN GEORGE GODDARD:—Did you find that you were obliged to make the wood framing somewhat stronger at the joints than would have been necessary with metal panels that really function like gussets to the frame structure?

MR. MERCER:—We had that in consideration at the time, and finally decided that it would make no difference. The door is an illustration. It is conventional. It would be the same as and no heavier than if we applied metal panels to it. We really do not anticipate trouble. It might happen that in some designs one portion would be weak on account of not having bracing, but we do not anticipate such a contingency in the construction that we already have fabricated.

The metal-panel body, in a sense, is rather peculiar. We get strength from the panels and, at the same time, the doorway cuts-out a large part of that strength; so, the body really is not so strong as it apparently would be on account of the steel panels being there.

CHAIRMAN GODDARD:—That brings up the question of the uniform flexibility of the body of a motor car. Engineers who have had experience in chassis construction know that we have gone to three-point engine-support in various forms to obtain flexibility of the chassis and to avoid cramping the crankshaft bearings and the power-plant in general. That means, naturally, that the frame will weave and become distorted temporarily. Very few body engineers have grasped entirely the meaning of that distortion and its effect on the body which is required to absorb it. In an open body, the door-openings practically cut the body into halves, and the sudden reduction in rigidity or, rather, the increase in flexibility, is localized at the sill section beneath the doors. It should naturally, then, be the object of the designer to design a body to be as uniformly flexible as possible; otherwise, he will localize this distortion, which is transmitted to the body, causing the opening of seams and joints between the moldings and the panels and undue wear on the lock-bolts, strikers and hinge-pins. This

particular body-construction strikes me as making the body even more uniformly flexible, and as possibly having some advantages in that direction.

MR. MERCER:—It is my idea that no points will be unequally strong. With the fabric construction and the wire and the buckram, the body is more uniformly strong than it would be with any form of construction now used. There are possibilities in the direction of its being the one perfect body.

CHAIRMAN GODDARD:—The one-day schedule for enameling bodies is really much less than one day. It is $3\frac{1}{2}$ hr. for three coats when the conveyor system is used.

MR. MERCER:—I knew it was a little less. I understood it was 7 hr. for the trimming and the enameling.

CHAIRMAN GODDARD:—Approximately $6\frac{3}{4}$ hr. from the unfinished steel body to the finished car, but the body while going over the enameling conveyor really undergoes four operations of enameling. For protection against rust, the enamel is sprayed on the inside and the under surfaces; then the three coats are applied successively to the body which, after each coat, passes through an electric oven having a temperature that varies from 450 to 600 deg. fahr., at a rate of speed through the oven that requires from 20 to over 40 min. per operation.

G. W. KERR:—Is that for open or for closed bodies?

CHAIRMAN GODDARD:—It is for open bodies. We are now in our first year of production of the closed body. The reason we use the fabric upper quarter at present is that we took advantage of the fad of the day, the fabric-backed body; and, while it is still in vogue, we shall find out how to enamel that upper back panel successfully without turning the body upside down.

We believe thoroughly in the all-steel body; some day we shall have it. The public is well satisfied with the fabric-backed, all-steel body, which is also quieter. We have fewer sound-proofing experiments to make and the time-element has forced us to use that construction. We have used the body for more than 8 years, and some 800,000 of them are in use. I have seen a body that was enameled in 1914 and has been taken good care of, polished and kept clean, which would take more than ordinary observation to note that it was not new. The enamel does not deteriorate but, owing to atmospheric and temperature conditions, merely collects a residue of bluish scum, as you might call it, a film that is removed readily with the proper kind of polish.

The steel body is in its infancy. I mean, not that every manufacturer eventually will make a steel body, because he will not find enough wood to make use of, but it is merely necessary to have a production of sufficient quantity over which to spread the die and equipment cost. Steel construction, enameled, in the end is cheaper than wood; and, when you consider that a body can be pressed out of the sheet, electrically welded, assembled and enameled in somewhat over one day of actual time, this is very different from the 106 days that it takes us to put through a sedan body from the lumber pile to the finished car. That, however, includes 18 or 19 days of painting operations.

L. C. HILL:—Will wrinkles appear in this material as it is exposed to dampness, rain, sunlight and temperature changes?

MR. MERCER:—I think that question can be answered by looking at the average high-grade fabric roof. A wrinkle very seldom develops in a roof, even after it has been out two or three years. The fabric is put on and is stretched; that is, hot water is applied to the inside, or the cotton part of the goods, then it is put on, drawn and pulled tight; it will shrink out. The effect is much the same as stretching paper on a drawing board.

Fabric that is made to imitate leather has one advantage over leather itself. Leather will sag in time and become stiff and hard. We anticipate, and it has been actually proved by 2 years of hard service, that this fabric will not show a deterioration in that time that would indicate that the goods were used up, or that the car was out of date, or did not look well; it still is in a state in which it is serviceable and will be presentable.

A MEMBER:—Your remark on the uniform flexibility required in body-construction brings up the difference between the requirements of an automobile body and those of a motor-coach. We built the motor-coaches that run on Fifth Avenue, New York City. A material of this sort, although it may serve a purpose in the passenger automobile, would not serve in larger construction such as that of the motor-coach, because we have found that steel panels and similar rigid paneling perform a definite function in the motor-coach. In an automobile body the supports are so close together, so closely interspaced, that the question of the strength of the covering does not arise, but in the motor-coach the question of the construction and the value of the covering is vital, because the steel panels, as a covering for the coach, perform a very necessary function in stiffening the frame and withstanding the stresses against the weaving of the coach and of the chassis.

The structural members, the timber members, are spaced more widely, and that fact makes a rigid covering more necessary. If the rigid covering were done away with, so far as the motor-coach is concerned, it would be necessary to increase the timber sections and to strengthen other parts, and that would tend to make the body more bulky. There is a decided difference between the problem of automobile design and that of motor-coach design.

CHAIRMAN GODDARD:—Inasmuch as reference has been made to my remark, I will qualify it, to refer to passenger-car bodies. The motor-coach type of body is assuming greater importance and very many more such bodies will be built, but I think the remarks just made refer to a coach that runs on solid tires on a smooth asphalt pavement. If that coach had pneumatic tires and were used in interurban service at speeds of 25 m.p.h. and greater, I think my remarks regarding the passenger-car body would apply.

A MEMBER:—Certainly. Greater flexibility would be required at higher speed.

P. W. STEINBECK:—Concerning the turn-under and side-sweeps, would there be bulging between the moldings, or should we be able to get a true line on the side-sweeps and turn-under?

MR. MERCER:—There is no bulging between the moldings that is noticeable. The screws are placed about $2\frac{1}{2}$ in. apart. We have no trouble of the kind you mention. The goods are fastened under the molding; they are nailed or tacked under the molding before the latter is applied, so that the goods are smooth. Then we place the molding in such a way that there is no chance for bulging. Do you mean that the molding would sink in?

MR. STEINBECK:—Yes. If you had a true side-sweep and wanted to eliminate as many moldings as possible, how would the side-sweep be affected, looking at it from end to end? Would there be a true torpedo-shaped line?

MR. MERCER:—We have considerable side-sweep on the body that I have mentioned. The side-sweep is more than the average. There is a large "round" at the back corner and the back also has a considerable "round," more than is usually the case. We have experienced no

difficulty at all. The goods, as I have explained before, are stretched tight and the foundation underneath is firm. It is not a soft, flexible surface, but is firm. For that reason we do not push into it.

MR. STEINBECK:—If you pull the fabric tight, it will draw to a straight line.

MR. MERCER:—It is similar to a built-up coach-roof. We applied the cloth over a solid foundation, as we do with a roof. Over that we put a wood-fiber or some other form of stiff panel; we pull the fabric over that and have no difficulty. It is a very old practice.

CHAIRMAN GODDARD:—You do not apply a layer of wadding under the entire surface?

MR. MERCER:—The surface is made full; the fullness is built-up before the goods are put on.

A MEMBER:—Inasmuch as this panel is so flexible, would it not be necessary to have a more rigid frame? After a body has run for about a year, the old-style panel acts as a gusset or stiffener. Would not the panel loosen and not reinforce the frame, in the same way as that of the old-style metal or wood panel?

MR. MERCER:—Do you mean that the frame would come apart where it is joined?

A MEMBER:—Yes.

MR. MERCER:—We are now demonstrating this. Anything that is a radical change has to be put on the road and tried out; that is the only way to prove it. We might theorize for the rest of our lifetimes and really get no satisfaction, for we do not prove it to any other person. For this reason, a body will be put on the road the first week of February and tried out over hard roads and through bad weather during the spring months to show just what will be necessary in the way of reinforcement. We hope that by fall or before, the test will be concluded. In the spring, from February on, a very severe test can be given a car that will amount to a year's ordinary driving. So we are planning to do that.

A MEMBER:—How about patching? Is that performed as easily as on a wood or metal panel?

MR. MERCER:—Yes.

A MEMBER:—On some bodies, we simply take out a panel and put another in.

MR. MERCER:—The mass or quantity production of today is tending toward bodies made in sections that are complete and can be assembled and replaced. A number of the new makes of cars have bodies made in that way. If that feature were carried out, it simply would be a case not of patching but of replacing the section that had been destroyed or damaged. That would be much easier than repairing it. We provide for repairs by replacements that are made easily.

A MEMBER:—How would it act on a side-chain bus, say a 35 to 40-passenger bus? Would it act like a metal panel on the bottom?

MR. MERCER:—I cannot see that it would make any difference. It will stand up and will keep out water, snow, wind and cold. That is practically all that a panel is supposed to do. For any contingency except a collision, it would be equally adequate. It is in use now for tops and roofs and nothing is thought of it. Formerly, we had solid-panel roofs, but they have all been replaced by the soft roof. It is only a logical step to continue with the rest of the body.

A MEMBER:—The side of a bus works differently from the roof.

MR. MERCER:—The excessive distortion of the framing in a bus would have to be taken care of by additional braces.

MR. BAILEY:—It seems to me that the most attractive feature of this construction is its elasticity rather than its lack of it. This body certainly would be elastic. When I study the elasticity of a closed body, I always get lost. I cannot see why any closed body with stiff panels ever can stand up; I do not see why it does not go to pieces. But in designing, we assume, of course, that the sill of the car should be stiff enough so that there would be no longitudinal undulation, but the two sides of the two sills cannot remain in the same plane; therefore, the body must twist and every closed body must twist. I assume that the only reason it stands up at all is that it twists at the door and that part of the body. Instead of making the frame of this body heavier, therefore, on account of the fabric panel, my idea is that it should be lighter; the joints should be heavy but the body should be lightened elsewhere.

By the use of fabric, we do not gain much in time, if anything, over enameling. We have the trimmer's time to put against that of the enameler; so, there is not much gain there. With regard to the stretching of the fabric, the roof is in a horizontal plane and the fabric on the side panels is stretched cornerwise. I can see that this might cause trouble. Another objection, a thing that might prevent its general adoption, is on the æsthetic side. Mention was made of the beauty and the style that were given to the landau by the long-grained leather in the upper panels. The same thing is being done in bodies today by building the upper panels that way; but the upper panel in a landau, or in any similar body, presupposes that it is to be folded up into a compact space; it was a superstructure on a paneled body that had rigidity and form. If we carry the leather effect into the lower panels we are violating the æsthetic idea.

MR. KERR:—I have made experiments on the twisting of closed bodies and have demonstrated that sound closed bodies can be twisted to a limited extent. I have mounted closed bodies on a limber chassis, with a three-point support, and have jacked up one wheel until I have twisted the chassis $1\frac{1}{2}$ in. lengthwise; the body showed the distortion but withstood the experiment.

In service, of course, they could not withstand a condition like that very long. Chassis engineers will realize sooner or later that the ideal should be the unbendable and untwistable frame. At the Salon shows last year and this year a chassis was exhibited that had a tubular cross-member of very large diameter, designed to prevent the twisting of the frame, and a frame of very deep and very wide section, designed to prevent bending. This year there was a frame, perfectly vertical, that had cross-members in diagonal form in the center of the chassis, an X through which the drive-tube passed. I recognized its object because, 6 or 7 years ago, I saw the experiment tried successfully of making an untwistable frame by placing the cross-members in a diagonal direction, crossing and forming an X, the idea being that if two lead pencils were laid, one across the other, and one were raised, the other would rise an equal amount so that the twisting strains would compensate.

I believe Mr. Mercer's construction would offer a flexibility in a closed body far greater than is possible with a paneled body, but it often happens, even with the stiffest bodies that, if the strain is too great, the glass will break. Glass breaks frequently because of a sudden twist. In the old carriage days, the frame of a coach, until it had been paneled, could easily be twisted; once paneled, it was absolutely immovable; it could not be twisted, and did not need to be, because the springs of the carriage were competent to, and did, take all the twist.

I believe that, in this body of Mr. Mercer's construction, it would be necessary to have very sound and well-made joints; otherwise, they would loosen under the twisting strain. But I think the body would be durable if the joints were good, and that, in most cases, the additional elasticity would be an advantage rather than a disadvantage.

I think a fabric top sags, not because it stretches, but because it shrinks. Leather tops on carriages always shrink. They often shrink until they pull away from the nails. As I understand it, the sagging of a fabric top comes from the fabric's shrinking crosswise, which pulls down the material so that it shows a bony appearance; it is not from swelling but from shrinking.

The substituting of a soft roof for the solid roof has, generally speaking, proved very satisfactory in the deadening of sound and in durability. In the old days, coach-building in England was done with leather as an outside covering for the wood panels. A green hide from which the hair had been removed was stretched over the roof and the side quarters and down over the back. It was nailed down, the edges were covered with molding, and then it was painted, roughstuffed, varnished and finished as if it were wood, but it obviated the danger of having the panels cracking and splitting.

ALVIN HUNSICKER:—I am partly guilty of the fabric that you have been talking about. I have about my neck a collar constructed so that the "stretch" has been taken care of. It is not a fabric; it is two fabrics, each constructed in a different way and the two are put together with waterproof cement. The stretch, the strain, the sagging points that you have mentioned, do not exist in this fabric. When we talk about stretching and sagging, the average single fabric is meant, but this is a double fabric; therefore, all the strain and twist and sag have been taken care of. It has been built to withstand the strains that it is expected to withstand. The soft top is used to get away from the rumble. There must be some rumble left in the frame. The flexibility of this frame certainly should be in its favor, no matter what you put on the outside. The sudden shocks and the twisting that an automobile gets are very bad when there is too much rigidity. We believe, apart from the fabric question, that a light flexible automobile frame has great possibilities.

CHAIRMAN GODDARD:—It is apparent that frames have been made more rigid, much stiffer, than they were in the early days. It is also a fact that springs carry a lighter load per inch; they are of greater flexibility. There should be no springiness in the frame. If there is, the spring in the frame will get out of step with the flexibility of the chassis spring, and the result will be unpleasant. The frame must be stiff; the springs must be flexible, as flexible as possible; in fact, many manufacturers are making the flexibility of the springs such that they are correct for three-quarters of the full passenger-load. In a five-passenger body, the springs are made to ride over roads of average condition with from 70 to 80 per cent of the load; with a five-passenger load, the frame will hit the bumpers on an extreme bump. That is done so that the man who rides alone or with one companion may have a good ride. The average number of passengers carried by motor cars, as checked by E. S. Jordan on street corners over a period of 6 months, was found to be 1.6 passengers per car. So, the chassis engineer who designs a car to carry three-quarters of the load without bumping the axles or bumpers is working safely in the right direction. A frame can be made stiff and still not be heavy or appreciably stronger than a similar section of less vertical height. Rigidity is what is required.

MR. HILL:—The National Automobile Chamber of Commerce canvass that has just been made, showing that 60 per cent of automobile owners want closed bodies and 40 per cent want open bodies at this particular time, ought to lead body engineers to concentrate their efforts on further decreases in the cost of closed bodies.

CHAIRMAN GODDARD:—In a fabric construction, such as that of the old landaulet and landau, we always applied the lead-filled moldings very carefully. Some of them were nickel-plated; others called for black enamel; in many cases, it was necessary to touch up or finish the molding after the fabric had been applied. That is not a production method. The moldings can be put through a low-baked enamel, not a high-baked enamel process. My experience has been that the best molding is filled with half-and-half solder, not lead. The melting-point of half-and-half solder is below the temperatures used with high-baked enamel.

MR. MERCER:—When fabric was used to cover the upper rear back and side quarters of the cheaper closed bodies that were put into the show a year or two years ago, the very imperfect method of fastening it at the moldings was rather disappointing to me. The lead-filled molding presents such difficulties that I think it is not possible to consider it in production. It would be difficult to get workmen who are capable of putting it on properly. Fabric-backed or soft moldings, so-called from the manner of the finish that is used for the interior trimming, never look well because they are not clearly defined. On the sample body, we used an ordinary oval 3/16 x ¾-in. aluminum molding, and put screws through it in a manner similar to that of the Rothschild construction. I do not mean to give that as an illustration; it was very expensive.

A body made by Budd and exhibited at the automobile show typifies the very cleanest form of construction that is possible in applying fabric panels. It is an all-steel body with the panel as an insert. I believe that manufacturers today are arriving rapidly at the point of making bodies in sections and of applying the different parts to the body. This method has great possibilities and many angles that will help to cheapen construction.

Budd's opening is like that of a window frame; the panel is an insert and a piping is applied that is only about ¼ in. in diameter; it closes the opening, makes a neat appearance and can be made by an average workman without too great cost.

The lead-filled molding is too expensive. When I first became interested in the fabric-built body 18 months ago, I found that the expense of making it was greater than that of a steel body. A steel body can be made cheaper than a fabric body unless we can get a better method of applying the fabric and of finishing it where the molding is attached. I think the best plan is to apply a separate panel and to put it on with piping made by bringing the fabric over a reed. The piping is ¼ in. in diameter and is fastened to the panel before it is inserted. The panel is pushed into and covers the opening. It makes a nice finish.

MR. BAILEY:—I have made a large amount of molding to take the place of the lead-filled type, and have used it with fair success on a series of bodies. We used half-oval drawn steel with spot-welded stubby-headed nails on the flat side. We could do it rapidly and without trouble. Spot-welding can be done by anyone. As the molding was of steel, we could use high-baked enamel. I believe I was a pioneer in enameling. We did a great

quantity of it and could dent the steel without spoiling the enamel. I have tried that with this molding very successfully.

MR. KERR:—Mr. Hunsicker spoke about the fabric eliminating all the drumming noise. It would eliminate all the drumming noise that comes from the roof, but the roof is not the source of all the drumming noise in a closed body. I have built closed bodies with aluminum roofs that had no drumming noise, and I have heard plenty of drumming noise in a body that had a soft roof. In a car that had what our English friends call "booming," I put my hands on the glass on each side and stopped the booming. In that case, the noise was caused entirely by the synchronizing of the vibration in the glass with that in the chassis.

MR. HILL:—An apparent rumble in the roof of one series of closed cars was stopped by adding 3 in. to the tail-pipe of the muffler.

CHAIRMAN GODDARD:—The roof picks up vibrations, one class of which is caused by the pulsating of the exhaust. Even in multiple-cylinder engines, lengthening the muffler tail-pipe or increasing its size steps the vibration up to a higher mile-per-hour speed so that the vibration, although still there, is not noticeable because the car is not driven often at the higher speed. In the early days, we eliminated objection to the noise by stepping it up to 30 to 35 m.p.h. At that time, closed bodies were not driven frequently at that speed.

The other is a mechanical vibration, in a four or eight-cylinder engine; the six, not being so bad as either of the others, must, however, be stopped by sound-proofing. Pullman cars, as everyone knows, are very quiet. They practically are all-steel cars. The roof is of steel and, according to the chief engineer, the company does not use, and has not used, wood-fiber panels on the inside, for several years. Steel panels and a means of sound-proofing them are used.

The noise from mechanical vibration is transmitted through the body-front structure and appears more in the front portion of the roof; in fact, a coupé or a small-compartment body seemingly will rumble worse than a larger one, and the roof will seem to vibrate in a narrow portion of the front. Some of the noise can be stopped by padding the front portion, perhaps between the first two ribs.

MR. MERCER:—The noise trouble in the body was overcome by one body-builder by changing the method of bolting the body to the frame. He said that he had put the first bolt close to the dash and had had considerable difficulty, but that he found that by putting the bolt back about 9 or 10 in. he had little or no trouble, because the front end was not fastened close to the engine supports.

MR. KERR:—To what body-maker does Mr. Mercer refer?

MR. MERCER:—Robbins, of Indianapolis.

MR. KERR:—My reason for asking is that I know of another company that originally fastened the body to the frame right at the dash, but it was found that the noise was reduced by attaching it about 8 in. back of the dash.

CHAIRMAN GODDARD:—I had a similar experience. I think it is because nearly everyone today uses a steel dash, if not a steel cowl. It is possibly on account of the effect of the three-point engine-support at about that point on the chassis frame and the tendency to stretch the dash like a drumhead; and also the fact that the dash is more or less a sounding-board and is closer to the engine than is any other approximately flat panel. Practically every motor car today has the steel dash, in which are corrugated ribs to stop the drumming effect. I think that fully one-half the drumming noise that is not in the roof is in the metal dash.

Returning to the types of construction or the constructional features that decrease the cost of the closed body, one of the important elements is, and always will be, quantity production, on account of the cost of floor-space. When all-steel body-construction cannot be used, the time-element must be reduced in some such manner as Mr. Mercer has described, by covering a body faster than it can be painted. Trimming in units and the bench assembling must be considered, so that the men shall not be in one another's way. Demountable construction must also be studied for the same reason that upholstery is made in sections.

A MEMBER:—Material always is the same; labor is always the same. The only way that the cost of bodies, except custom-made or special-made bodies, can be cut down is by making them as simple as possible. We can give a straight line to the outside but we must make the bodies as simple as possible and avoid all frills. That will tend to speed up production. The time saved by discontinuing fancy designs naturally will be put into the construction of many more bodies and will reduce the cost. Dispense with all moldings that can be dispensed with.

CHAIRMAN GODDARD:—Fad and fashion are making it easier every day. The easy-flowing line is backed by reason. It is easier to fabricate, is more pleasing to the eye, is less faddish and does not become tiresome; the buying public also is in favor of fabric at present. Everything tends toward helping the engineer solve the problem.

MR. HILL:—Have you had any expression of public opinion on the trimming of the inside of closed cars with artificial leather?

CHAIRMAN GODDARD:—There is a somewhat large difference of price between a sedan, trimmed in mohair velvet and painted and varnished on the outside, and the all-steel body. The all-steel body is enameled; it is black; the inside is trimmed with Spanish leather on the cushions and backs, and imitation leather on the sides. If the prices were equal, we might be able to determine whether there is a preference. The farmer wants a closed car just as much as the man in the city, and he wants to be able to use that car in emergency during the week. It is difficult to answer directly the question whether the public prefers leather, or hard-finished trim, to fabric. The reason for using mohair velvet is very similar to that for using leather. The car has a higher resale value. The biggest item in settling the appraisal value of a motor-car is the paint. Enamel finish answers the paint question. The inside is trimmed in fabric, which is nothing more or less than the outgrowth of the car-plush used by the railroads. There are objections to mohair, as there are to broadcloth and other woolen fabrics, and there are objections to leather, but the main reason we use it is utility.

H. B. DAY:—I am not an engineer nor a mechanic, but I had the first California top that was made. That was in 1916. The first fabric-covered car was in 1918; so that I have had over four years' experience with it. With regard to the cloth wrinkling, when some parts of the car were covered with wadding underneath the cloth, the fabric would work out and crack; and it made no difference what the fabric was. I have had fabric on the running-boards instead of linoleum, with a light-weight carpet between the board and the fabric. It worked well and did not wear out. It was cemented to the running-board, and is practically as good as new today. I have one car on which fabric has been in use for body-covering

for over 4 years and on which it is still in use. The car has been driven over 60,000 miles, including a trip to Philadelphia and back; and I think the roads I encountered in Arizona and Colorado were never so bad. The car has been out in the desert and in the snow, has been exposed to salt water and to the sun where we have 8 to 9 months of heat each year. The car looks nearly as well today as it did the day it was turned out. It has had no varnish.

As to the use of fabric for lining inside the car, that is commonly done on California tops. Its use is increasing. The fabric does not deteriorate and can be cleaned. A real California top will last as long as the car will last and will look well for 5 or 6 years.

L. L. WILLIAMS:—Why is the theory not advanced that, instead of mortising joints, the joints should be half-lapped and a screw sunk in? Glue costs a certain amount per pound. If a man is working on piece-work, he will not leave his bench to get fresh glue; he will put hot water into the glue he is using. Why not omit the glue and put in a screw, provided the screw is driven in with a screwdriver instead of being hit with a hammer.

We ought to get a definite idea of what can be done to produce a body at a minimum cost on a production basis in the way that the majority of builders necessarily produce bodies. They cannot continue to build bodies in the way they have been building them. The cost is prohibitive. I see no reason that makes it necessary on cars of a certain price to have a door that must lap three times to keep out possible draft, and put a weather strip inside it. You do not put a half-dozen jambs on the door of the tightest house ever built; you build a threshold for the door and fit the door to it. Of course, the door does not hop about as it does on a chassis.

I think it is the duty of the engineer to assert himself and say that he can cut the cost of a body if the sales department will sell it. If they cannot, then he must increase the cost of the body. If we are building bodies at a high cost, we can do anything we choose, but I think the cars we have in mind are those with closed bodies at a lower price. Why specify silvering quality plate-glass when, as a matter of fact, we will not have a bit of plate-glass in that specification?

On a very inexpensive closed body, I have seen as many as five screws driven into the top weather-strip of a door, when two, or at the most three, would hold it; and nails put into a panel $1\frac{1}{2}$ in. apart, when we could not get the panel off if they were 4 in. apart. I think it is not necessary to build straight-sided bodies. A large part of them could be put on a rocker form and sent through a planer just as if they were straight.

CHAIRMAN GODDARD:—Mr. Williams has brought out a very important angle of the object of this meeting, namely, to discuss how the closed body can be made less expensive to use, not necessarily cheaper. Any one who brings out a very cheap body is likely to get a backkick from it. The body must function properly; it must be built on a framework; whether the framework is of steel or of wood, the joints must be made to withstand rough usage.

Mr. Williams brought up a point about rabbeting the door. We formerly used rabbets on the hinge on the sill-pillar and on the top rail. Now they have simmered down to the lock-pillar alone. It is possible to discontinue that rabbet and the expense of that machine operation. There are a great many points that have not been discussed thoroughly enough with reference to decreasing the cost of closed-body manufacture.

MR. STEINBECK:—Has not that question been answered by the making of bodies for cheap cars? Can we make cheap bodies and put them on high-grade automobiles? Are there not enough different classes of body made today to answer Mr. Williams' question? We can make them without rabbets. Taxicabs are made much more cheaply than limousines. All that sort of thing costs money. You could not put that kind of body on a cheap car, but you could put it on a high-grade car. We might take up the same question with the chassis. Why do we not get a chassis for a high-grade car at the same price as that of a chassis for a cheap car? Because quality is required from the chassis engineer as well as from the body engineer. So far as prices are concerned, speaking from the standpoint of a body-maker, I think they are low enough today, but it is true that we would like to get them lower and make a slightly greater percentage of profit.

CHAIRMAN GODDARD:—The whole matter goes back to the question of quantity production. I feel safe in saying that the Ford sedan body, or any other similar body that is made in similar quantities, is made more accurately than a body for the highest-priced chassis that ever was built. That is only possible through quantity production when the cost of jigs, tools, fixtures, dies, forms and the like can be spread over a large quantity. The cost will take care of itself when the quantity is specified; operations can be made more simply and more cheaply by increasing the equipment for performing them, but Mr. Williams at least has suggested things that might be done. We ought to consider the body purely from the standpoint of design, from the standpoint of what each particular part of the body does and what its function is. Decrease the number of joints, use a higher grade of lumber, perhaps, with lighter sections; in general, study body-construction purely from the standpoint of the functioning of each individual piece that goes into the structure.

THE HARDWOOD-LUMBER NEEDLESS WASTE

BY FREDERICK F. MURRAY

THE production of hardwood lumber has not kept pace with factory development, particularly that which has taken place in the automotive field. Some persons maintain that lumber is not susceptible to "development"; but all sorts and conditions of hardwood lumber are produced from the same tree and only a part is suitable for automotive construction. Some portions of the tree are far more suitable for furniture manufacture, while others are peculiarly adapted for use in parquetry and in building trim. Development, therefore, consists of properly differentiating the various kinds of material that come from the hardwood log so that the various industries may have at their disposal boards that have been properly classified. As the present system of grading has been in effect substantially without change for over a quarter of a century, years before the automobile came into general use, the grades originally established have little bearing upon automotive utility. Revised specifications for grading that would determine the major requirements, which in themselves include the secondary requirements, would on the whole obviate much of the waste that occurs under the present method.

Designating the grade in terms of the cut-up value

would provide a real and much needed simplification and avoid many existing inconsistencies. It would tend to discourage manipulation, the substitution of inferior grades and other irregular practices, that though reasonably infrequent are detrimental to the industry. Hardwood standardization is a component part of a general movement that involves all species of lumber, both softwood and hardwood, that is crystallizing in an organization recently instituted in the city of Washington and known as the Central Committee on Lumber Standards. This committee is endeavoring to produce a new and scientific grading-schedule that by common accord will establish a lasting instrument to be entitled the American Lumber Standards. [Printed in the January, 1923, issue of THE JOURNAL.]

THE DISCUSSION

CHAIRMAN G. W. KERR:—How would it be possible, by a change of the grading rules, to arrange things so that the body-builder will get more material out of the plank and the lumber producer more money out of the log? The title of this paper has brought the thought that a short-cut would be to have Mr. Hoover prevail on Congress to pass a law prohibiting the use of hardwood lumber in the building industry, and letting the furniture, automobile and agricultural implement industries have all the hardwood. These industries must have hardwood, but the building industry could get along very well without it.

The modern methods of cutting up lumber are exceedingly rapid, so much so that although the rate per hour of the workman and his earnings per day are probably three times what they were a decade ago, yet the output of pieces is much greater proportionately than the increase in the cost of getting them out. That fact probably leads to the use of first and second grades; whereas, some years ago, the manufacturer was inclined to buy rather more of the common grades.

F. F. MURRAY:—When I was in Memphis in 1922, I heard considerable discussion about making hardwood 2 x 4-in. lumber. That would be more or less of an innovation, backed solely by the idea of creating a better market for the low-grade hardwood stock. The 2 x 4-in. size made of yellow pine will allow any number of defects in the first grade, provided the 2 x 4 remains sound and the defects do not detract from the strength. By using a 2 x 4-in. size made of hardwood, which might have many knots or other defects, the member would then be even stronger than the 2 x 4-in. size made of soft wood.

Hardwood producers are also looking to the railroads for a greater consumption of low-grade hardwoods. Within the last year there has been considerable development in the use of gum ties. A few years ago, hewn cross-ties of white oak were specified. Possibly the only difficulties with the gum tie are that it must be treated within 2 weeks from the time it is cut, and that it should be cut when the sap is not flowing. By treating a gum tie immediately after it is cut, the incipient stages of decay are controlled and the tie has exceptional wearing qualities, defying mechanical wear and rot. The wooden cross-ties in the Pennsylvania terminal at New York City are of gum.

J. S. BURDICK:—What position does texture take in the grading program?

MR. MURRAY:—When we go into tabulation in the automotive field, we shall pay particular attention to the texture requirements and, judging from my brief experience in the factories at Detroit, production managers and engineers are not silent on that subject; so, I think we shall get plenty of data with respect to texture.

The producers are very anxious to serve the consumers in every possible way for the betterment of the trade, a reason that is, in effect, both philanthropic and selfish. The differences that have occurred have been due to a lack of understanding, and the data that this general lumber standardization seeks will be fully as illuminating to the producers as to the consumers. The producers have no exact idea of what the factory cut-up requirements are. Such information as the producers have at present has been obtained at second or third hand through the jobbers or the wholesalers, who are in more or less direct contact with the field, while only the larger producers have facilities to manage all of their sales directly with the consumer. Many expert salesmen who are traveling in the interest of lumber companies, either wholesale jobbers or producers, endeavor to learn what the particular requirements of each factory are, so that they can serve it with special lumber. That is doing what this movement proposes to do on a large scale.

AUTOMOBILE FINISHING-VARNISH

BY L. VALENTINE PULSIFER

AS the success or failure of the finish of an automobile depends largely on the finishing-varnish, a plea is made for more scientific analyses of the problems of automobile finishing and more care in selecting and applying a suitable varnish. The qualities to be desired in a finishing-varnish are divided into two classes: the shop qualities and the service qualities. The shop qualities include color, body or viscosity, working, flowing, setting, hardening, fulness and the safety of working. The service qualities, or those that enable the varnish to withstand the various conditions of use, include resistance to break-down under the chemical action of the actinic rays of sunlight, to the destructive action of moisture and the alkalis in mud and soap, to expansion and contraction, to vibration and to abrasion. The three most important factors in estimating the service-giving qualities of varnish are said to be elasticity, moisture-resistance and the film factor. Each of the various terms mentioned is carefully defined, analyzed and explained. Among the constants that must be determined, either for checking uniformity or for use as bases of tests, are the non-volatile content, which is the starting-point in the test for elasticity and in computing the film factor or thickness of the dried film; the ash, the flash-point, and the acid number. An empirical formula is derived by which the thickness of the dried film can be estimated with accuracy; and in a series of appendixes the details are given concerning tests for the drying, the safety of working, non-volatile content, ash, flash-point and acid number; the Kauri reduction test; and tests for moisture and alkali resistance. [Printed in the January, 1923, issue of THE JOURNAL.]

THE DISCUSSION

S. G. TILDEN:—Are any of the many body polishes on the market, either wax preparations or otherwise, worth considering?

L. V. PULSIFER:—So far as adding life to the varnish which many of these things claim to do, you may be sure they do not. In many cases, when they contain abrasive

or some dry-washing material, as they frequently do, with the idea of avoiding the washing of automobiles with water, they are destructive, because the operations, both of putting on and of washing off the polish, fill the surface with scratches that tend to break what we might call the selvage edge of the varnish. The varnish on old paint that has become dull can be increased in brilliancy by waxing, but it is no longer a varnish job; it is a wax job and, when it is done over, there is trouble. You can rub the varnish down and finish it but, if it has been waxed, to make the new finish adhere you must take the surface off and get down to the base.

CHAIRMAN G. W. KERR:—What influence has moisture in the varnish-room on drying?

MR. PULSIFER:—The drying of varnish is, of course, of a chemical nature. It is the chemical absorption of oxygen by a component of the varnish. A certain percentage of moisture, which varies with the temperature, will assist in the drying and is desirable to prevent the varnish from setting too rapidly. If there were no moisture, the thinner or the solvent in the varnish would be so great that the varnish would not set. On the other hand, it is possible to have too much moisture in the varnish-room, and I have known of cases where the cooling of the film condensed specks of moisture on the drying finish and caused pitting of the enamel.

CHAIRMAN KERR:—What is the percentage?

MR. PULSIFER:—That depends on very many factors. As a rule, a difference of about 20 deg. between the wet and dry-bulb temperatures is desirable. If the temperature is as high as 120 deg. fahr. with forced-drying systems, the wet-bulb temperature should be around 80 or 90 deg. fahr.

F. E. MCCLEARY:—Has much work been done with violet rays as a substitute for sunlight? Is there any use in working with them?

MR. PULSIFER:—The violet ray is produced by a form of lamp that is supposed to give off the maximum number of actinic rays that there is in sunlight. An attempt has been made to expose films to the action of violet rays and then to stretch the films by an apparatus arranged to give a uniform pull. The method thus far has been experimental. It has not been so successful as the Kauri reduction test and is much more complicated to make.

In the second place, the ratio between the time of action of the violet ray and the stretch that the varnish should show under a given test has not been established. The violet ray is used for the purpose of determining the permanent character of pigments, and for testing pigments that are to be used on inside-wall paints. An attempt has been made to use it on deteriorating varnish. Thus far the number of variables and the time necessary for carrying out the work have prohibited its use to any great extent.

HERBERT CHASE:—Is it feasible to secure a durable finish that is not lustrous, one without a high polish?

MR. PULSIFER:—There are two ways in current use for producing a durable finish that is not lustrous. One is the use of material similar to oil paint, containing so much pigment that no luster is apparent on drying; in other words, the particles of the pigment stick up to such an extent that there is no shine. Another way is to rub down a varnish, such as a chassis varnish, to a dull finish, after it has dried for 4 or 5 days. An attempt has been made to produce a varnish that would dry flat, but no varnish of this kind has shown durability; in other words, the material that must be added to the varnish to cause it to dry flat, destroys the life of the varnish and the varnish can be used only on cheap interior work. Rubbing the varnish down produces the better appearance of the two perhaps, but opinions differ as to that.

MR. CHASE:—Is the rubbed-down varnish durable?

MR. PULSIFER:—Yes, if the right kind of material is used. It frequently is not durable for the reason that an attempt is sometimes made to add enough rubbing-varnish to an ordinary body-varnish so that it can be used as a finishing coat. Rubbing-varnish has a much shorter life than finishing-varnish and adding 1 qt. of rubbing-varnish to 3 qt. of finishing varnish will reduce the life of the finish one-third. By using a material such as a chassis varnish, which dries so hard that two coats are required to get an adequate thickness, the work will last as long as if it were left bright. The durability is reduced by the amount that is rubbed off, and by the scratching of the film; but it is possible to get a satisfactory finish by that method, if the material is right.

MR. MCCLEARY:—Nothing has been said with reference to the hardness of the finish, which is a thing we are all interested in. Would the hardness affect the elasticity, or can that be obviated?

MR. PULSIFER:—The hardness of varnish is difficult to define. In the first place, a rubbing-varnish, as a rule, dries harder than a finishing-varnish, yet a rubbing-varnish is much more susceptible to abrasion. It is toughness that enables the varnish to resist abrasion. Frequently, a varnish that is called soft in drying will be the best, for the reason that it has this quality of toughness, which prevents the abrasive material from taking hold. It is toughness rather than hardness that prevents the rubbing that it gets while being washed from cutting the film. Hardness, of course, is absolutely the determining factor in many cases, when a certain production schedule is to be maintained and the body must be dry enough so that it can be hung at a certain time. The determining factor is the kind of material that is used, but if the results that are obtained from a varnish that dries too fast and too hard were better understood, perhaps more time would be allowed for the final application, and the day or two extra that would be required could be saved somewhere else along the line without slowing up the production speed. Any system that results in allowing more time for the application of the varnish will double the durability, if correctly used.

A method has been devised for testing the hardness of varnish by finding which one of a series of pencils, such as are made by the pencil companies, varying from 20 to 30 deg. in hardness and sharpened to a chisel point, will cut through a varnish-film that has been dried under certain conditions on certain metals. This is considered a measure of the hardness. It is a question in my mind which is the thing that counts, toughness or hardness. It is the toughness rather than the hardness, provided the varnish dries hard enough so that things will not stick to it. That is about the only requirement.

N. G. SHIDLE:—In the durability-rating chart, the varnish *D* is about six times that of varnish *A* in total points. Would the relative price of those two varnishes be 6 to 1?

MR. PULSIFER:—It probably would be 2 to 1.

MR. SHIDLE:—I notice the relation between the totals is 6 to 1, and you say that the resistance to exposure conditions is proportionate to the elasticity. That would make varnish *D*, 16 to 1.

MR. PULSIFER:—These two varnishes show two elasticities; one is extremely thin and extremely nonresistant to abrasives, while the other is extremely resistant to those abrasives. Other things being equal, the

elasticity would determine the durability. In this particular case there would be a wide range of resistance to moisture, which is the chief difference. The value of the moisture factor is complicated, and would vary in different climates.

CHAIRMAN KERR:—What is the cause of rusting under the varnish coat?

MR. PULSIFER:—If an automobile is painted properly, the coating, barring accidents such as cutting through, is about as tough as can be imagined. The pigment is very dense to the penetration of moisture, which means that if the finish is destroyed by rust from below, the rust must have been there in an incipient state before the primer was applied; and it is not always easy to determine whether the body is absolutely free of rust. Various methods for eliminating the possibility of rust on the surface have been devised, but the best of them will fail occasionally. This point cannot be attended to too carefully.

ALLEN KENDALL:—In the tests for turning varnish white, would there be the same action with salt water as with fresh water?

MR. PULSIFER:—Salt water, as a rule, is not so severe as is fresh water in turning varnish white. That is a thing not commonly understood. The water that will turn varnish white most rapidly is distilled water, which contains no alkali whatever. In an alkaline action, the alkali in the water will assist in breaking down the film. I suppose the idea came originally from the fact that vessels on the seacoast lose their varnish very readily, but that is on account of exposure rather than sea water. As a matter of fact, the water that causes the most damage to vessels is not seawater, but dew and fog, which consist, of course, of practically pure water. It is a bad thing to get salt on the deck and walk on it. The salt acts like any other abrasive. Salt water, by itself, has less effect on practically any grade of varnish than has pure rain water.

LAWS GOVERNING GASEOUS DETONATION

BY THOMAS MIDGLEY, JR., AND ROBERT JANEWAY

THE authors present in this paper an explanation of gaseous detonation based upon what are considered incontrovertible laws, and show by the functioning of these well understood natural laws that gaseous detonation is a phenomenon that does not require any hypothetical assumptions to account for its existence.

The physical conditions that must exist within an inclosed container when it is filled with an explosive mixture of gases and these gases are ignited are stated and analyzed mathematically, and an application of this analysis is made to the internal-combustion engine. The apparatus and the procedure are described, inclusive of photographs and charts, and it is shown how the formulas can be applied (*a*), for constant throttle and varying the temperature of the entering charge and (*b*), for constant temperature and varying the throttle opening and the compression-ratio. The results are illustrated and discussed in some detail.

Appendix 1 refers to the basic equations in the paper and has as its object the combination of these equations

$$P_1 - P_2 = W^2/g\ (V_2 - V_1)$$
$$W = KD_1^n T_1^m$$

into a single fundamental expression containing P_1 and P_2 as the only variables.

Appendix 2 is a mathematical determination of the critical pressure of detonation. [Printed in the April, 1923, issue of THE JOURNAL.]

THE DISCUSSION

CHAIRMAN H. L. HORNING:—With respect to Mr. Midgley's equations, remember that we have K, the coefficient of chemical reaction; times D, the density of the charge; times T, the absolute temperature; and that these are the three fundamental factors.

P. S. TICE:—Will Mr. Midgley explain Fig. 8 in further detail?

THOMAS MIDGLEY, JR.:—Fig. 8 shows the change in pressure with the variation of temperature. The sloping lines show the critical pressure at which detonation takes place, as the temperature is increased. Thus, as the temperature is increased from say 85 to 100 deg. fahr., P, the critical pressure at which detonation takes place, drops from around 220 to 198. At the same time, when we heat the manifold, we do not get any such drop-off of maximum pressure, because the drop-off of maximum pressure is only due to the slight reduction of volumetric efficiency.

A MEMBER:—In connection with Fig. 8, what fuels were you using? What was the tendency of the fuel to detonate as the specific gravity drops or as it increases?

MR. MIDGLEY:—We used only one fuel. A complete description of the fuel is given in Fig. 12. It was a kerosene. The temperature of 72.2 deg. fahr. for critical dissolution with aniline proves the fuel to have been of pure paraffin constitution. No comparisons have yet been made between two different fuels.

A MEMBER:—If crude oils of 28 to 38 deg. Baume are used as engine fuels, at what values will detonation occur?

MR. MIDGLEY:—That is one of the next steps in this work; also, to find out just what the anti-knock material added to a fuel affects.

A MEMBER:—The equations relating to detonation developed by Mr. Midgley relate only to the particular engine under consideration. The tendency to detonate would depend upon the relation of the fuel to the spark-plug. If the spark-plugs are located so that the distance of burning is short, the time must be short. If the time is limited, detonation cannot take place. So, it is possible to increase the pressure without having detonation by keeping that point always in mind.

MR. MIDGLEY:—That is right, within reasonable limits.

E. S. CHURCH:—Regarding detonation tube-experiments, the statement was made that the explosion ends up with a loud bang. Suppose the end of the tube was closed and the noise shut off from the end where the ignition started, would any noise have been perceptible to a person in the chamber where that end of the tube was located?

MR. MIDGLEY:—That has not been demonstrated experimentally, but everything we know about force indicates that the end of the tube would be distorted by having the high pressure hit it suddenly.

MR. CHURCH:—Then the speed of the detonation wave, somewhat approaching that of the sound wave, when striking the walls of the chamber, would have the effect of setting them into vibration; it would not be caused by the knock.

MR. MIDGLEY:—With an open tube, the sound is simply

a continuation. However, where we have something like a heavy iron wall to penetrate, the natural thing is to expect that it will be the distortion of the wall that will produce the sound, rather than that the actual sound will be transmitted. Consequently, the sound and the nature of the sound depend very largely upon the shape of the chamber that it strikes.

MR. CHURCH:—In Fig. 4, the waves of compression, traveling horizontally across that space, would produce an excessive pressure upon one side of the piston and not on the other. That might have several effects. It might have the effect of distorting the piston; it might have the appearance of producing a side slap on the piston. Now, if the location reduces the tendency to produce the ill effects of detonation, is not the ill effect of detonation due to that eccentric loading more than to any innate pressure?

MR. MIDGLEY:—No. Of course, the mechanical effects of detonation are influenced largely by where the detonation-wave strikes. A good heavy engine-construction will withstand considerable punishment without showing any noticeably ill effects. During the intense-luminosity period, there is an enormous amount of energy radiated as heat. I measured how much heat was radiated and how long it took. If that radiation were held constant for 1 sec., the top of the engine would melt. This loss is occurring right at the top of the stroke, when all the heat one can get is needed for the expansion stroke; consequently, this radiation loss, due to detonation, means a decided loss of both power and economy.

ALLEN KENDALL:—Your formula indicates that detonation takes place after a certain pressure. The statement was made that detonation is a matter of time. The pressure should rise to a certain point, regardless of the shape of the cylinder and regardless of the length of the flame. We do not get the same audible indications in the two cases.

MR. MIDGLEY:—The only explanation is that the critical pressure is reached before the velocity of the flame increases. Before the high pressure of detonation can be attained, the gas in this wave must become dense; but, before that gas can be crowded into that amount of space, the flame has to move an appreciable distance. The point at which detonation is set up is very sharp and, at that point, the flame suddenly jumps to a high velocity. Then the distance factor is involved. It has nothing to do with the equations themselves.

A. D. REESE:—In the expression for W, was the value for K determined experimentally; if so, was it determined at high pressures?

MR. MIDGLEY:—It has a meaning only if you accept this theory of the mechanism of detonation. The actual results obtained were used to determine the constants and the exponents. You can extrapolate from those if the theory of the mechanism is correct.

S. G. TILDEN:—Does the addition of an anti-knock compound postpone that point where the curve shoots up to the speed of sound or absolutely do away with it?

MR. MIDGLEY:—It postpones the effect. How much it is postponed depends upon the quantity of anti-knock material used.

DR. H. C. DICKINSON:—In reference to the effect of cylinder size and to distance of flame travel, will Mr. Midgley state, in the case of an explosion started in a tube 2 ft. long and another explosion started in a tube 1 ft. long, whether detonation in the two cases would occur at approximately the same relative position in the tube? In other words, are the shape and size factors taken care of by the equation in that way or not?

MR. MIDGLEY:—With regard to the tube experiments, if the length of the tube is increased, the tendency for it to detonate is increased because there is a longer column of gas to be moved. In tube experiments, we have found that we might have a tube 4 ft. long and no detonation; if we add 6-in. to the length of the tube, detonation will start at 3 ft. because of the added 6-in. column of air and the increased inertia.

DR. DICKINSON:—I refer to the experiments with the closed tube.

MR. MIDGLEY:—I do not know. According to the equation, detonation should occur at the same pressure, provided the same heat influences are present. At the point where detonation starts, however, the high pressure has not as yet, necessarily, been generated; a certain amount of shoving is necessary to compress the gas into the wave area. It probably takes a little distance to build that up. It might vary with the different sizes of bombs.

O. C. BERRY:—If, in a cylinder, the flame starts from a certain point and a flame-cap passes through the gaseous mixture, the temperature ahead of the flame-cap probably will be considerably below the burning temperature of the gas, and the temperature in the flame-cap will be very much above the burning temperature. Before this gas ahead of the flame-cap can burn, it must at least come up to the kindling temperature. Its ability to do that amount of work will depend upon how much energy it has to do that work with. We are told that there is a pressure-wave ahead of this flame-cap and, if that pressure-wave gets to be very high, we can see that the temperature in that pressure-wave will be raised, due to the heat of adiabatic compression. Has the problem been analyzed from the angle of associating the point at which the high rate of flame propagation sets in with the point where the temperature of this adiabatic compression gets up above that unstable condition in the temperature of the gases themselves?

MR. MIDGLEY:—There is no relation between that pressure and the auto-ignition point of the fuel. The auto-ignition point of the fuel is the temperature really necessary to cause the combination of oxygen and hydrocarbon with an instigator, with something right adjacent to it or corresponding to a point of the flame-front itself. The point at which the mixture becomes unstable instead of metastable is very much higher.

Mr. Berry also raises a question regarding the mechanism by which flame propagation is obtained. He brings up the fact that, in order for the next row of molecules to be affected, a certain amount of energy had to be given up by this flame-front. We feel we have some superficial evidence at least that the thing that determines the reaction velocity is how fast these molecules are breaking down, and not how fast they are combining with oxygen.

W. S. JAMES:—Prof. F. W. Stevens has been working at the Bureau of Standards on the flame velocities in gases, using two methods that are entirely independent. The results so far substantiate, in general, what Mr. Midgley has said. One of the methods used is known as the Bunsen-Guoy method. In this method the shape of the inner cone of a special bunsen burner is recorded photographically. When the entrance-gas velocity is known, the velocity at the surface of the cone, where the reaction is taking place, can he computed. At this surface, the gas velocity is equal to the flame velocity. In addition to this method, he has devised what he calls a constant-pressure bomb. That is nothing more or less than a soap bubble filled with explosive mixture of known proportions and fired from the center. The explosion

within the bubble is then photographed on a rotating film through a narrow slit. The outside of the original bubble is shown on the film for comparison with the final size. These two methods are entirely independent; but, in general, the results have been of a nature that confirms exactly what Mr. Midgley has said concerning the velocity rate when plotted against what might be termed the mixture-ratio.

L. H. POMEROY:—With respect to deposits on the outside of cylinders, I have attempted recently to measure the deposit on an aluminum water-cooled cylinder after 15,000 miles. Although small patches of scale a few thousandths of an inch in thickness could be observed here and there, in general, the slightest scratch with a knife blade revealed bright metal. As a non-conducting medium, I would lay odds on the deposit of oil mist, dust and decomposed floræ and faunæ on the fins of an air-cooled engine after the same mileage.

AN EXPERIMENTAL SURVEY OF GASOLINE AND KEROSENE CARBURETION

BY C. S. KEGERREIS AND G. A. YOUNG

REALIZING that great quantities of fuel are being wasted yearly by improper carburetion, the results of several investigations are assembled and considered from various viewpoints. Some pertinent data have been published previously; therefore, only a general discussion of gasoline carburetion requirements is presented in this paper. The scope of the paper is too broad to include a detailed discussion of any one subject. However, the data have been compiled to allow the graphs to explain many points that could not otherwise be touched.

The kerosene research is particularly valuable, not so much in outlining the requirements for burning kerosene as an automotive fuel exclusively, but for the carburetion requirements necessary in using our future petroleum fuels satisfactorily. Supposing that the future fuel will embody hydrocarbons boiling up to 550 deg. fahr. as a limit and containing sufficient volatile fractions to allow engine starting even in cold weather, the authors feel that kerosene will lie within the limits of efficient carburetion.

In addition to the ideal requirements, data are shown to prove the reasons for the present wastage of fuel. This is illustrated by the metering characteristics and allied data obtained from a few commercial carbureters, the data being used merely as a comparison with the ideal requirements. The change of temperature of fuel and air causes a change in the metering characteristics and the metering is not as desired. In addition, there are the temperature requirements of fuels that must be recognized, thus making the problem of carburetion truly complex. [Printed in the January, 1923, issue of THE JOURNAL.]

THE DISCUSSION

P. S. TICE:—There are several outstanding points regarding which my data differ considerably from those of Mr. Kegerreis. If we compare gasoline and kerosene in the same engine, with equal charge temperatures and substantially no fuel liquid on the manifold wall in either case, the mean-effective pressures and the thermal efficiencies are found to be almost exactly equal, with a slightly less exhaust-heat loss and proportionately greater loss in the jacket for the kerosene, if there is no detonation. This statement is substantiated by work with four different engines in which the work was done very carefully and thoroughly. If we continue this direct experimental comparison of the two fuels, the mixture-ratios for maximum power and for maximum thermal efficiency seem to differ only as the calorific values differ; that is, the kerosene mixture is slightly leaner than the gasoline mixture.

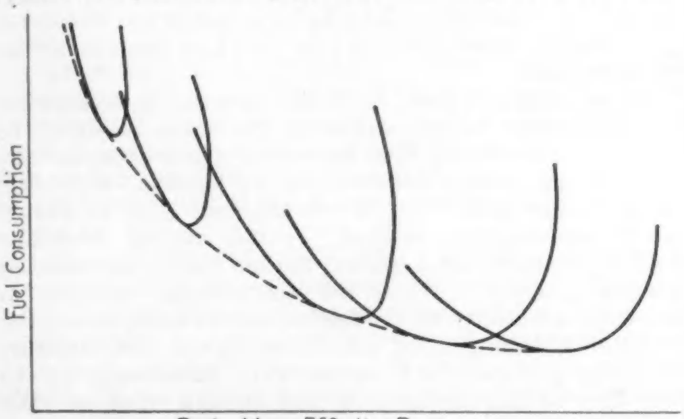

FIG. 40—CURVES SHOWING THE RELATION BETWEEN THE BRAKE SPECIFIC FUEL-CONSUMPTION AND THE BRAKE MEAN-EFFECTIVE PRESSURE

I find that the maximum efficiency is not obtained at the lower limit of regular inflammability, as stated by Mr. Kegerreis. It seems that he must have arrived at this conclusion as a result of the natural limitations of his method of preparing the charge, since his limits throughout represent more fuel in the charge than the proportions found to give maximum efficiency. The characteristic graphs, Figs. 40 to 43, show what I mean.

In Fig. 40, we have a plot of brake specific fuel-consumption against brake mean-effective pressure, covering the whole load range at a constant speed. Each one of this family of curves represents a constant manifold-pressure and, therefore, a substantially constant amount of air pumped by the engine. In each curve, the right-hand end represents the richest mixture that was used, and the left-hand end the leanest mixture that would fire regularly. No attempt was made to define the regular combustion limit on the rich end, although it was accurately defined at the lean end. Obviously, the envelope curve, shown dotted in Fig. 40, represents at any output the minimum possible specific fuel-consumption under the conditions of the runs. The point I want to make is that the mixture values at the lower limit of inflammability for regular engine operation are widely spaced from those giving optimum economy. My work shows fairly consistently, with either gasoline or kerosene, that the lower limit of regular inflammability is about 0.0445 according to Mr. Kegerreis' method of stating mixture proportions; that is, about 22.5 to 1, the way the rest of us state it.

Experimental examination of a considerable number of engines shows that the relationships between optimum mixture proportions and relative load are independent of the engine speed in well designed engines in which the valve-timings are not too much distorted from best values at either end of the speed range. A plot of substantially the most economical air-fuel ratio values for a typical car engine is shown in Fig. 41.

As is well known, mixture strengths resulting in least specific fuel-consumption do not deliver the maximum

power at open throttle. At the same time, there is no object in running with maximum-power mixtures when maximum power is not demanded; that is, optimum metering characteristics in a carbureter will maintain the minimum-consumption mixture-proportion throughout the greater part of the load range, and will enrich the mixture to cause maximum power delivery as full load is closely approached. This desired change in the air-fuel ratio is shown by the dotted curve at the full-load end of Fig. 41.

It is interesting to combine the level-road engine-load versus car-speed curve as in Fig. 42, with the optimum air-fuel ratio versus relative-load curve, as in Fig. 41. For several reasons, the "relative" load is, in car operation, slightly less at some speed higher than the minimum or idling speed of the car. Combining these curves gives the optimum air-fuel ratio versus level-road car-speed curve having the characteristic shape shown in Fig. 43.

C. S. KEGERREIS:—In regard to the mixture-ratios required for maximum thermal efficiency, Mr. Tice criticizes the results in the paper based on the given power basis and then, in presenting his data, he discusses the problem from the load or constant-manifold-vacuum viewpoint. The two methods are entirely different and,

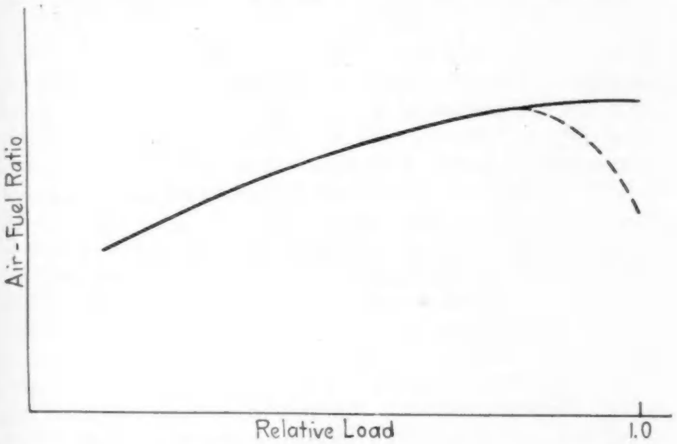

FIG. 41—CURVE OF SUBSTANTIALLY THE MOST ECONOMICAL MIXTURE-RATIO VALUES FOR A TYPICAL CAR ENGINE

if Mr. Tice will review the paper, I think he will recognize the error in his comparison.

The lean limit of inflammability will vary somewhat in different engines and also with the method of hot-spotting the manifold. In the tests that Mr. Tice reports, a limit of 0.0445, or 22.5 to 1, is exceptionally lean and is rather extraordinary if this limit is a constant with respect to the engine load. I have recorded data from a few engines that show the limit as low as 0.0400, or 25 to 1, but the limit was not constant for the load and is entirely beyond the average line for the usual engine. It certainly is gratifying to find Mr. Tice's data checking so closely with those reported in the paper under the heading of mixture requirements for change of engine speed.

In developing a relationship between the car-speed for level-road operation, and the optimum mixture-ratios, a general characteristic curve can be drawn, but this curve will change for each individual car. It is true that in many cars the idling speed does require a higher "relative" load than some higher speed, but this relative load is a variable for different cars at the same speed. Thus, as the engine load affects the ideal ratios, the ideal mixture-requirements will vary in value at the same speed

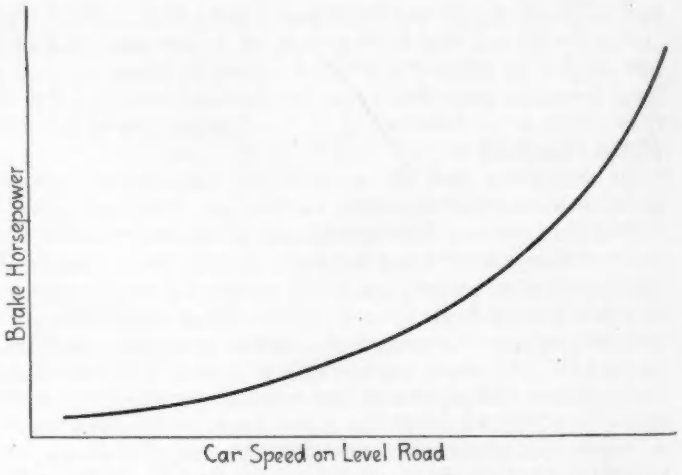

FIG. 42—CURVE OF THE LEVEL-ROAD ENGINE-LOAD PLOTTED AGAINST THE CAR SPEED ON A LEVEL ROAD

for each individual car. Given a certain engine, the car weight, the wheel diameter and the gear ratio will determine mainly this relative load at the lower level-road car-speeds.

H. S. MCDEWELL:—Were the inlet-air temperatures of the mixture above the carbureter taken? The method of obtaining reproducibility by an orifice plate between the carbureter and the manifold, while fine from the standpoint of reproducibility, does not give actual operating carburetion conditions due to the fact that there is an obstruction in the system totally different from that of the usual throttle. As a result, there is not the usual distortion and, consequently, not the usual effect on the liquid distribution; in fact, there may be some reatomizing effect from the fact that the usual creep of liquid along the side walls will be caught at the throttle plate and may be reatomized at the edge.

The so-called carbureter-testing plant is the most deceptive apparatus that ever was built. It gives a beautiful comparison between two different carbureters under steady-flow conditions, but they are not engine conditions. The biggest change from engine conditions is the fact that, while there may be artificial pulsations in the flow, they are not the actual reversal of flow or flow-back conditions in an actual engine.

MR. KEGERREIS:—The inlet-air and the mixture temperatures were taken in all cases; some are presented in Fig. 25 of the paper. The use of an orifice between the carbureter and the manifold, with the throttle removed,

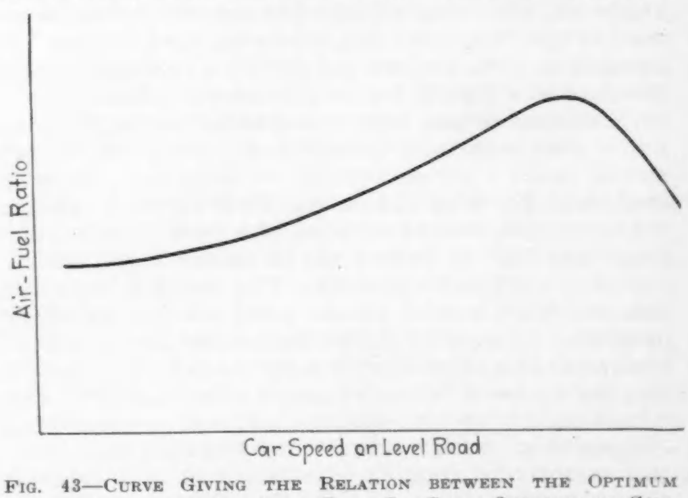

FIG. 43—CURVE GIVING THE RELATION BETWEEN THE OPTIMUM MIXTURE-RATIO AND THE LEVEL-ROAD CAR-SPEED OBTAINED BY COMBINING THE CURVES OF FIGS. 41 AND 42

probably changes the conditions somewhat. With the carbureter used, the atomization at idling was probably not as fine as if the throttle had been in place. The big improvement over the butterfly throttle-operated job is that there is no feathering of the charge into either leg of the manifold.

In discussing the accuracy of the carbureter testing-plant as compared to engine conditions, I think it can be stated that no one has ever determined conclusively the exact difference between the two. In this particular case, carbureters have been run in the plant and on the engine. Comparing the tests, for example, when using the carbureters whose characteristic curves are given in Figs. 34 and 36, the same characteristic curve is obtained on either plant and at nearly the same flow-rates. It is absolutely admitted that the pulsations in the two cases are not comparable, but whether the error is of an appreciable magnitude must be established by further investigation.

E. H. SHERBONDY:—There are two things a carbureter does; it meters the fuel and the air, and it diffuses the fuel throughout the air. So, we have various kinds of choke and spraying devices, to get the fuel into the air. Two years ago I was developing a powerplant to get its utmost performance. We wanted to get mean-effective pressures for a motor-car engine that were comparable with those commonly secured in aircraft engines; we wanted to get flexibility and silent operation, manifold depressions that would be similar to those for aircraft-engine carbureter-operation, since an aircraft engine is called upon to run at fairly high speed all the time. I built a system of this kind, using an air-meter and experimenting to find out why the pressure drops were so enormous, and why so much pressure was lost in the air passing through the carbureter. All that is required is to have a pressure drop great enough to atomize the fuel. I found, for instance, that with a $1\frac{1}{2}$-in. carbureter, with a properly designed air-chamber below the venturi tube, I could pass the same number of cubic feet through a $1\frac{1}{4}$-in. carbureter that I could get through any $1\frac{3}{4}$-in. carbureter made in America.

MR. KEGERREIS:—The explanation by Mr. Sherbondy of the critical point where the high frictional loss was found may be the cause in some carbureter bodies. The case of the carbureter, the results from which are represented in Fig. 34, is somewhat different. The elbow was removed, allowing the ends of the venturi and the nozzle to be the limiting factors. The same frictional loss was present whether the elbow was in place or removed. The nozzle was next removed, allowing only the venturi to remain in the airstream; then, of course, the frictional loss dropped to a rather low value. This information was procured at a high flow-rate through the carbureter. It is interesting to note that, in carbureter bodies, the placing of the choke valve is important. On a new experimental model I am developing, no choke was originally employed. No other change was made except to add the ordinary choke valve positioned at a certain angle. The result was that the airflow was increased 10 per cent.

J. G. WILLET:—An important fuel loss has been overlooked. When a car reduces speed quickly, as in approaching a corner in traffic, the accelerator is released and the engine is being driven by the car; the result is that the engine is being fed an over-rich mixture. This is noticeable when the car is accelerated, on account of the usual black smoky exhaust shown at the time. It not only wastes fuel, but it deposits carbon and tends to dilute the lubricating oil. Could not these troubles be overcome entirely by a system in which the fuel delivered to the engine by the carbureter is controlled by the pressure developed in the engine cylinders, which corresponds with the load on the engine? Such a method would not only vary the fuel delivered to the engine in exact proportion to its load, but would cut it off entirely when the engine was being motored by the car.

MR. TICE:—In further discussion of the point just brought up, the conclusion that an examination of Mr. Kegerreis' work leads to is that the variation in the strength of the mixture must be made with the load, not with car speed or engine speed or rate of airflow. As to the matter of a mixture being too rich under one operating condition and too lean under another, that represents nothing more than the fuel lag that we have to put up with in our present commercial intake-manifold. To have the manifold deliver to the engine the mixtures that are delivered to the manifold by the carbureter, there must be certain amounts and varying quantities of liquid in the manifold and on its walls. So long as an intake system makes it necessary for that to happen, just so long will we have widely changing mixture proportions every time we change the throttle position.

CHESTER S. RICKER:—Many of those present will remember driving cars in which this film on the walls of the manifold that Mr. Tice mentions might be left there when the car is running forward. I remember a car that was built 10 years ago with clutches that would only drive in one direction. If the car started to coast, it coasted as though it had a coaster-brake on it; the engine maintained whatever speed it had or slowed down gradually. If this condition exists, as these carbureter men suggest, I am wondering whether that might not be considered as a mechanical development to assist the car in gaining the maximum economy?

W. L. DEMPSEY:—The engine people have as much right to improve the engine as the carbureter people have to improve the carbureter, and I believe we can get a real insight into our troubles if we will stop for a moment and analyze the Diesel engine. The Diesel engine does not waste any fuel in the crankcase. It is the most economical of all of our engines, and it will burn practically anything that is put into it. What is the fundamental reason why the Diesel engine, operating as it does under all conditions on practically any grade of fuel, does so without any wastage into the crankcase? I believe it would not be fair to say it is the fault of the carbureter, because the Diesel engine has no carbureter. From the time the fuel goes into the Diesel engine until it is completely burned and exhausted, the temperature never drops below about 900 to 950 deg. fahr. There is always an excess of oxygen in the Diesel engine. The fuel of the engine is made up of the petroleum spheres which grow like a bunch of grapes; it is represented by CH_2, or 1 atom of carbon and 2 atoms of hydrogen. Every time we add 2 atoms of hydrogen and 1 atom of carbon, the boiling point of that particular molecule, if we consider those between CH_2 and C_2H_6 or on up the line as the molecules enlarge, increases about 60 deg. fahr. It is not only necessary that this molecule be broken up before the carbon and the hydrogen can be free to unite with the oxygen of the air to make complete combustion, it is not only necessary that the temperature be brought up to a point where the energy that is given to the atom by heating it is stronger or greater than the natural affinity of each atom for the other, but it must be maintained at that temperature during the whole time that the fuel is in the process of combustion; otherwise, whenever it drops below that critical temperature it must necessarily condense, and we will make a complete mixture in the

carbureter and condense it before we get it into the cylinder.

If one watches any well-made manometer and varies the throttle, this will vary the compression, and if one varies the compression this will vary the temperature of compression. To my mind, the reason that the Otto cycle, with its throttle-governed system, burns more fuel per horsepower than the Diesel engine, is because it wastes more fuel into the carbureter because the temperature has dropped. It is all right to talk about fogs, but you cannot explode a fog. You never get combustion and explosion until you get a dry gas; and, whenever the temperature drops below the temperature of the dry gas, that amount of fuel is bound to exhaust. The only way to get efficient carburetion out of the fuel is to mix it with the air and get the atoms into as close proximity as possible. A peck of potatoes comprises large and small potatoes and, when they are baked in an oven, the large ones require more heat than the small ones. We have the same situation here; it takes a little heat to vaporize the smaller particles and a greater amount of heat to vaporize the larger ones. If we can devise some scheme to maintain the temperature at 250 deg. fahr. through the carbureter, we will get economy at that; but if we maintain the temperature from the time the air strikes the carbureter until the time the compression is completed, we will increase the economy. Therefore, if we can maintain a uniform compression in the engine and if we can make it impossible for the fuel, the liquid, the spray or the fog, to touch a water-jacketed wall that cannot be much above 212 deg. fahr., we will help to solve this difficulty. We cannot very well keep a dry gas of molecules that requires a temperature of 500 deg. fahr. to vaporize them by spraying fuel against a water-jacketed wall that has a temperature of 250 deg. fahr.

Two important things must be improved in an engine. First, it must be furnished with sufficient oxygen to have 1 atom of oxygen for each 2 atoms of hydrogen, and 2 atoms of oxygen for each 1 atom of carbon. Second, the temperature must be maintained from the time it enters the cylinder until the end of the compression stroke. By so doing the economy will have increased decidedly, and the engine will burn practically anything that is put into it.

A. D. T. LIBBY:—Did Mr. Kegerreis, in these experiments with kerosene, make any attempt or experiments to feed superheated steam into the engine simultaneously with the kerosene mixture?

MR. KEGERREIS:—In these experiments the compression-ratio used was about 4.6. At 70 lb. per sq. in. it gave some detonation, of course. We used no water whatever; they were pure kerosene and atmospheric air mixtures.

NEIL MACCOULL:—What experience has Mr. Kegerreis had in measuring mixture temperatures? In Fig. 25, he shows a maximum temperature drop of about 50 deg. fahr. between the temperature of the air going into the carbureter and the temperature of the mixture, when the air going in is at 250 deg. fahr. In some experiments we have made, we have tried measuring the temperatures of the mixtures at the various points in the manifold. At every place we put the thermometer, we got a different temperature, but we found the minimum temperature drop with "motor gasoline" to be more than 100 deg. fahr. with air supplied to the carbureter at 250 deg. fahr. We are conscious of the fact that there are wet-bulb conditions going on in measuring the temperature of the mixture, but if vaporization proceeded to a point where the mixture is saturated, one would assume that a wet bulb should not give a temperature below that of the actual air and fuel mixture.

During these runs, was the spark kept at a constant advance or was it advanced in each different test to give the maximum power?

MR. KEGERREIS:—The mixture temperature was measured approximately about 10 in., I should imagine, from the carbureter; that is, the mixture went around a 90-deg. bend between the thermometer and the carbureter.

The conditions of spark-advance with respect to temperature were constant. With respect to load, of course, they were necessarily held for high-power conditions in all cases, and that meant some retardation at the higher loads; not so very much, but some. Also at the maximum load, 100 per cent load, some diethyl selenide was used to suppress the detonation. I think you will find, with respect to detonation, that one of the curves will show its effect on the power at the higher temperatures and the half-load condition.

F. C. MOCK:—The conclusions of the paper as to fuel mixture requirements are, in general, those held by our own engineering organization for a number of years, and their accuracy has been proved by many tests, on a great number of engines. We find, however, and I believe this will agree with the observation of many of our members, that the exact requirements of mixture proportion are different with each design of engine; as a matter of fact, they may be different with the same engine at different times in its service. Probably at the highest mixture temperatures reached during the test described in the paper, and certainly at the lower temperatures under which passenger-car engines operate most of the time, there is a definite portion of the fuel unvaporized in the intake-manifold and distributed to the various cylinders with a degree of inequality depending upon manifold contours, air velocity, the temperature and the volatility of the fuel. The requirements of mixture delivery from the carbureter for best engine operation will, of course, vary with this inequality of distribution. The quality of the mixture leaving the carbureter can easily be different from that received by a given cylinder, and the carbureter setting must always be a compromise that will average up best among the different cylinders.

The result of all this is that a considerable amount of experimental work is necessary for best results from a given engine. First, in finding the mixture requirements, then in setting the carbureter to comply therewith. The idea of a "mail-order" carbureter, which could be furnished, with fixed adjustment, from specification of the bore, stroke and number of cylinders of the engine, never has been and never will be practical. Given, however, complete information as to an engine's requirements, I am very sure that carbureters can today be obtained which will come much nearer meeting these requirements than the authors of the paper seem to believe.

I am rather certain that it will never be desirable to do away with adjustments on a carbureter for passenger-car service. This is not on account of the variation in the mixture delivery with the temperature, for this, even according to the values given in the paper, amounts only to about 3 per cent or perhaps ½ mile per gal. on either side of an average setting, for a 100-deg. fahr. temperature change. Such a change is minor in comparison with the change in the fuel requirements of the engine for good acceleration, or for full power at low speed, under a 100-deg. fahr. temperature change, or at constant temperature with different fuels that can be bought from adjacent filling stations in many of our cities.

Since the required adjustment is dependent upon fuel characteristics as well as upon temperature, any thermal adjustment on the fuel-jet, set and locked at the factory, will probably waste as much fuel as it saves on cars in general service. A successful automatic control of the fuel-jet would have to be so intelligent that it would function according to the intake-manifold temperature, the engine temperature, the entering-air temperature, the manifold vacuum, the manifold velocity and *the volatility and the viscosity of the gasoline*.

MR. KEGERREIS:—Mr. Mock's discussion is very timely and, being presented by a representative of a large commercial carbureter company, where the results, no doubt, were procured largely from actual car installations as well as from laboratory work, they bear out the general findings of our researches conducted wholly in the laboratory. I am sorry Mr. Mock seemingly has taken for granted that the few instances cited in the paper cover the results of all the carbureters observed on the testing plant. However, it can be stated, that, knowing the complete engine requirements, there are very few devices that will approximate the ideal. These data will be published in complete form at a later date.

In connection with the discussion of the automatic control of the fuel-jet, it is fairly certain that a jet can be designed such that it will inherently compensate for the entering-air temperature and the viscosity of the particular grade of fuel that is being used.

COORDINATION OF THE MOTORBUS AND THE STREET RAILWAY

(*Concluded from p.* 436)

the full support of the public, has required that it be assured against losses from operation in territory where there are not enough inhabitants to guarantee a return upon the money invested in the extension. In Baltimore we have a similar situation. The requirement by the railways that they be assured against loss when they give service that is designed primarily to increase the value of somebody else's holdings, is a perfectly just and reasonable one.

MOTORBUSES AS RAILWAY AUXILIARIES.

The development of a motorbus that can be operated at the minimum of expense, will make it easier for people living some distance from a rail line to get transportation, although at a higher price than is charged for rail service. By extending motorbus lines from the termini of rail lines or from other points into sparsely settled territory, railways are enabled to serve sections that could not hope for rail service for many years to come. When the railway does this, the people are assured of a permanent service and property owners are encouraged to build homes. As the district grows, the time comes when service can be given more cheaply by the railway and then the railway company is justified in extending its rail lines into districts that have been built up by motorbuses, transferring the buses to still more remote sections. When such territory is served by individuals or unregulated drivers, the community has no assurance that the service will be permanent. A fly-by-night jitney driver may be able to serve a community for a limited time at a low fare, but his day is short and, when it is done, the people find themselves marooned unless the railway company, with its years of experience, comes to their rescue.

I could quote from many reports and present many arguments on this subject, but I know that you are well aware of the facts. Let me say in closing that the prosperity, comfort, convenience and intellectual growth of the people depend primarily upon the establishment and maintenance of a transportation service that is reliable, permanent and efficiently conducted. There has not yet been developed any transportation service of this character, except that of the steam railroads and the electric railways. As a representative of the electric-railway industry I want to say that my industry recognizes the great service that can be rendered through the use of motor vehicles, and that it is using them and will use more of them in the future; but further, that any policy of competition which unwise automobile advocates may adopt is certain to be ruinous to themselves and to the railways, whether they be steam or electric; and once a railway stops operating it is extremely difficult to restore the service.

I trust that I have made clear to you in this discussion the fact that if your great industry and the electric-railway industry will cooperate, far greater benefit will flow not only to us, but, what is more important, to the public that we serve.

The Retailer and the Engineer

By Harold B. Wess[1]

Cleveland Automotive Transportation Meeting Paper

THE author recognizes the engineer as the proper medium of an effective control in industry because he has the power to visualize minutely, in advance, the product as it will appear and operate when completed, to think and to plan on paper and to adhere to accurate mathematical thinking in making decisions as well as in the conduct of his operations. He states that these qualifications can be applied to advantage in any branch of a retail organization today.

The application of engineering principles to retail-organization management is discussed and the expense sheet of retail business is mentioned as being the point of contact at which the automotive engineer can assist the retailer in reducing operating costs by improving delivery service. The author suggests automotive concentration upon the construction of an improved light parcel-delivery truck, as well as one of heavier type for delivering merchandise in bulk and transporting furniture.

AS engineers you, to my mind, represent the constituent of industry that is being recognized as the proper medium of an effective control over the ever-expanding organization problems. Whether the engineer has been trained along electrical, automotive or civil lines, or any other form of construction and planning, he has essentially those qualities that are most needed in industry today. He has the power to

(1) Visualize minutely, in advance, the product as it will appear and operate when completed
(2) Think, and plan on paper
(3) Adhere to accurate mathematical thinking in making decisions as well as in the conduct of his operations

In any branch of a retail organization today, it is evident how essential these three qualifications are, and the engineer is especially trained to fulfill them.

Let us consider the merchandising branch. What do we find? When the retailer's business was small and the individual merchandise man could keep in close physical touch with every item on his shelves, all was well. When merchandise increased to such unusual volume as to make such intimate contact impossible for him, he had to resort to the engineering method. Therefore, the progressive merchant outlines on paper a complete plan of what his stock should normally look like from month to month, not in dollars and cents, but in physical units. Just as the engineer reassures himself by referring from his machine to his plan, so the merchandise man always refers from his actual stock conditions to the plan that he carefully drew up. In all of his operations, he is more and more beginning to visualize his sales, his stock and his turnover, with the same mathematical accuracy and the same graphic and mechanical methods as those employed by the engineer. As the engineer sets up accurate mechanical devices to guard against too high or too low a temperature, to make sure that he is not caught unawares and probably too late to replenish or adjust his machine, so the progressive merchandise man sets up similar reliable safeguards by which he knows daily whether he is running short in any of many hundreds of rapidly selling items, or whether he is being over-stocked in any of the slow moving or staple articles. He does not order items blindly; like the engineer, he refers to his prepared plans and builds his business structure in accordance with them.

Application of Engineering Principles

If we take any other branch of the retail organization we will find that this engineering method is being applied. Peculiarly enough, this engineering method, or what I should prefer to call engineering psychology, is much more used in the so-called non-merchandising departments in the retail organization. As yet, it has not fully invaded, or made itself felt as a motivating force in merchandising problems; but there is no question that the time is coming when the merchandise man will find that the "walking delegate" form of executive control will be inadequate. He will find himself in the same position as a teacher who tries to keep 100 children all together and in step. When the teacher runs up to the front of the line and tries to adjust the pupils, the rear is disorganized and, by the time he returns to the rear and attempts to bring them into step, the front is out of step and in disorder. So, the inexperienced teacher keeps running up and down in a frantic effort to have a completely organized marching unit, with no other reward than aching feet. The walking-delegate type of executive is in the same position. Just as he has adjusted one difficulty in his organization and plugged up one hole, behold, another trouble is started. The reason is very simple. It is all due to the fact that the operating control does not emanate from a centrally conceived idea. The various sections or units do not tie-up into one central point.

Imagine a ship on the ocean guided from several different points, each directing it at will, instead of being controlled by one radio station. It would be a very wabbly ship, and what applies to it usually applies with equal force, figuratively speaking, to the wabbly ship of industry, or to any part of an organization. Only he can truly be called an executive of the highest order who adopts the engineering method, carefully controlling his organization from an organized plan, built up with mathematical precision; a man who is guided by this plan just as the captain of a ship is guided by a compass; one who can control the movement of his ship of organization with the same certainty as if he had concentrated all the engineering energy within one central radio station.

You are automotive engineers but, because you are *engineers*, I know that, whether I talk on retailing or on any other branch of industry, you will apply to it a mode of thinking that is bound to be well balanced, accurate and reliable.

Department Store Expense

I invite you to take your place on the expense sheet of the retail business, because it is the sheet on which the retailer is concentrating all his energies today. It is the sheet on which the retailer is expending sums of money that might well go into his own profits, if it were not for the fact that he wishes to cut down the expense so

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that the public will benefit. The retailer was attacked severely in regard to high prices in 1920 and 1921, but the true state of affairs, as reported by the Bureau of Business Research of Harvard University, was that department stores earned 1.7 cents per dollar of sales during 1920, and 1.3 cents per dollar of sales during 1921. An analysis of earnings of similar kinds of business shows that the department store is one of the lowest on the scale. That is inherent in the requirements of department-store service.

The chain store can earn 10 cents per dollar because its service to the consumer is at a minimum. That is equally true of many other forms of distribution to the public. The department store, however, must render a high type of service and, in its effort to give a minimum price to the public at the same time, it is bound to get a lower return for its selling dollar than is true in many another form of distribution.

Automotive engineers are in a position to help the retailer bring down his costs of operation in one particular form of service. I can speak for our own store, and point to the great efforts being made to analyze our various operations so as to increase their efficiency, all being with a view toward decreasing our costs and giving that benefit to the public. For instance, we conducted and are still conducting an investigation in our delivery branch of service, in which you are particularly interested. We sent out four trained college men who have spent months on the delivery wagons in analyzing very accurately, with stop-watches, every possible motion made during the day in the various phases of delivery operation. Thousands of repetitions of each motion were recorded and, when all of the data were gathered and studied, we were able to arrive at some fundamental conclusions. We are still looking forward to developing some very valuable standards to guide us in operating our delivery service with a maximum of service to the customer, and with a minimum of expense to the store and to the customer. We are doing that in every branch of our business. We are applying the engineering method. However, when we come to use equipment and supplies for our service that we are bound to purchase from others, we have no control over them. We may expend a great amount of money to determine the best methods of operation and to find out how to save here and there.

When a store like ours invests its energies and its money for the improvement of methods and for the saving of operating expenses, it is not only doing so for the business and for its customers but, by conventions and through publications, it is contributing to other organizations the information that it has gained by its own efforts. If every retailer and if other organizations followed the same policy, and many of them are doing so, we can see easily what an important motivating power such approach in modern business would become and what a powerful force for placing modern industry on so efficient a basis as to make it impregnable to the criticism of the most radical in our social organization. We could bring modern industry to an efficiency that would cause the public, which now and then is amenable to certain prejudices, gradually to develop much confidence in the retailer. The public would soon realize that the retailer had reduced the cost of service that the customer wants.

Types of Vehicle Desirable

As to the place of automotive engineers on our expense sheet, we can do much to improve our methods and reduce our overhead but, when we are confronted with materials that we must purchase from the outside, we have a right to tell these people that we are expending all our energies and utilizing our resources for the reduction of our overhead cost, and to say that we expect them to do the same for us insofar as the supplies and equipment we purchase from them are concerned.

The retail field today is not only applying its best efforts individually to improve its operating methods but, collectively, it has organized toward the same end. For example, the National Retail Dry Goods Association, an organization built-up for the purpose of placing retailing in the foremost position in modern industry, through its operating associate groups, is not only helping to build the highest form of retail organization, but it is making its contribution to other industries. If we consider, for instance, the Controller's Congress, an associate group of the National Retail Dry Goods Association, we find that the accounting system it has just developed has created such active interest among industries outside of the retail field that it is rapidly being adopted in one form or another by others. A group that is of greater interest to automotive engineers is the International Retail Delivery Association, which is now affiliated with the National Retail Dry Goods Association, as an associate. Here we meet annually to find ways and means of reducing the expense of operating our delivery system.

There is one expense, however, that we cannot reduce without your assistance, and that is the expense as it particularly applies to the motor vehicle. How much study have you really given to the problem of the department store as it applies to the motor vehicle? Can you honestly and truly say that you have built a motor vehicle to fit the needs of the retail field? The express company and the shipping company uses its vehicle to deliver merchandise that is mostly heavy. Its stops are certainly not short. I know of no other industry that has the problem of house-to-house delivery, where mileage is really a minor factor. I know of no other industry where a certain phase of its delivery equipment is concerned with merchandise, where weight is a small factor. I could continue to mention the particular differences between the retail requirements of the motor vehicle and that of other industries. Has a real study been made of the requirements of the retail field so that a truck can be constructed that is in every respect a retail truck? I hope I am wrong but, from my discussions on this subject with men in the field, I think that has not been done, or certainly not to the extent that the importance of the problem warrants.

Recently, I spoke of the need of placing on a truck a body that is essentially a retail body. Such a body would reduce sorting and loading operations and would assist materially in an efficient delivery. So far, no effort has been made to experiment particularly with a delivery body. My intention is to appoint an Automotive Construction Committee from among the members of our Association, who, because of their particular training along these lines, and with the assistance and cooperation of our entire membership, will present to you what they think are the particular requirements of the construction of a light parcel-delivery truck, as well as of a heavier type needed for bulk and furniture deliveries. With your engineering training and application, and your cooperation, so directed, these vehicles should produce results that would cause you to feel that you have assisted the retailer materially in bringing down his expense.

Vol. XII May, 1923 No. 5

Successful Tractor and Semi-Trailer Railroad-Terminal Haulage

By J. F. MURPHY[1]

CLEVELAND AUTOMOTIVE TRANSPORTATION MEETING PAPER *Illustrated with* PHOTOGRAPHS

THE author describes a system of automotive transportation for intra-city hauling and the movement of merchandise between railroad terminals that has enabled the company he represents to serve the city of St. Louis and the railroad terminals there with a high degree of efficiency through the utilization of tractor and semi-trailer units and a thorough supervision of their movements. The units are described and illustrated, and the conditions governing their usage are set forth.

The salient features include the necessity for adequate terminals, off-track versus on-track railroad depots, the volume of tonnage, tractor and semi-trailer operation and methods of procedure and control, weight and protection of loads, haulage distance, economy, and a specific statement of the principal advantages gained through the use of automotive equipment of the type described.

ALTHOUGH I am not an engineer and possess no technical knowledge of the construction of a motor truck, it has been my observation that the motor truck of today is a dependable machine that, for practical purposes, is perfect mechanically; and that the limit of its use as a medium of transportation will depend upon its intelligent application to business and the proper application of business to the vehicle. It is my opinion, therefore, that if the motor truck in any branch of what may be termed "commercial service" is not working as an economic and efficient unit to its theoretical capacity, it is because it does not fit by its construction the conditions under which it must be operated or, if it does fit the conditions, its operation is not systematized so as to get from it the full measure of efficiency that it is capable of giving. Motor-vehicle equipment, as operated today in commercial hauling, is a sort of hit-or-miss proposition; that is, many of those who adopt it for use in their business fail to make a study of the conditions under which it must be operated, or to supervise its operation so as to obtain the maximum results.

My experience in automotive transportation has been in intra-city hauling and the transportation of merchandise between railroad terminals. In that service we use a unit that, by its construction, fits our business, and we have systematized its operations so that we are getting from it the full measure of economy and efficiency. In addition, it has enabled us to perfect a system of terminals in St. Louis that supply a vital transportation need for both the railroads that serve the city and the business community there.

ADEQUATE TERMINALS NECESSARY

One of the most important problems that confronts the rail-transportation interests of the Country today is that of adequate terminal facilities in large cities and, in its solution, two factors must be considered; (*a*), the intra-terminal transportation of merchandise interchange between railroads, and (*b*), the intra-city transportation of merchandise between railroad terminals and the store or plant of consignee or consignor. In these factors service and cost are of vital importance to both the railroads and their patrons.

It is a recognized fact that the capacity of our railroads is fixed by that of their terminals. It is obvious, therefore, that such facilities as tend to relieve the rail terminals of business that can be handled otherwise correspondingly increase the capacity of the rail terminals to handle the volume of freight that, on account of its character, must move through such channels and, perforce, increase the capacity of our railroads as a whole.

In St. Louis this is now being done by the company I represent. Using semi-trailer automotive-transportation, it relieves the rail terminals of virtually all of the less-than-carload freight that is interchanged between the Western trunk lines terminating in St. Louis and the Eastern railroads having depots in East St. Louis, Ill., across the Mississippi River, as well as the major portion of the less-than-carload merchandise shipped from and destined to St. Louis proper. Thus, in the correlation of rail and automotive transportation for the handling of both interchange and St. Louis merchandise it has been made possible to handle carload and less-than-carload business more expeditiously in St. Louis than at any other terminal center in the Country.

For the handling of the less-than-carload merchandise of a city, adequate freight facilities mean terminal facilities sufficient to handle such traffic promptly, with freight depots located so as to be accessible at a minimum drayage haul to the greatest number of shippers and receivers of less-than-carload freight. In St. Louis such facilities are furnished by our company in the operation of universal off-track depots conveniently located, to which merchandise shipments for any one or for all of the 24 railroads serving that city, including the Illinois Traction Co. and the Federal Barge Line, may be delivered to or from which incoming freight from any or all roads may be obtained, thereby reducing the cartage or haulage expense to shippers and receivers of freight.

OFF-TRACK VERSUS ON-TRACK RAILROAD-DEPOTS

These universal off-track stations serve the railroads and the business community better than would on-track railroad-depots by virtue of the following facts: A universal freight depot on-track for the receipt and delivery of less-than-carload merchandise for all St. Louis railroads would, by its perforced location, entail an increase in drayage expense to shippers and receivers of freight. Moreover, such a universal freight depot of sufficient capacity to handle the less-than-carload merchandise of all St. Louis railroads and permit the loading thereof in box cars, so as to insure through service with a minimum transfer of shipments from car to car en route, would require, if located at a point convenient to the greatest

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number of shippers and receivers, a space of such size that the cost of its acquisition would be prohibitive. One universal freight depot on-track of less than that capacity, or several such stations on-track, would not represent adequate facilities; for, in the interest of service and the conservation of box-car equipment, the transfer or consolidation of shipments at other stations would be necessary. In addition, such handling, owing to the light loading of this class of freight, would take a large quantity of equipment from other service for which it might at the time be needed urgently, to say nothing of the additional tax that would be placed on the rail terminal-facilities in the handling of these cars. The location of individual freight depots in St. Louis by each railroad for the handling of less-than-carload merchandise would not insure better service to shipments, and it would increase the cartage expense of shippers and receivers of freight, unless they should have straight loads to and from each depot, which, with most of them, would be very infrequent.

A shipper's truck loaded by 1:00 p. m. could scarcely deliver freight to 12 or more different railroad depots between that hour and 5:00 p. m.; whereas, if delivery were made by 2:00 p. m., which could be done to the most conveniently located of our universal off-track depots, we would make delivery of the shipments to the 12 or more railroads in time for forwarding the same day. This applies likewise to inbound shipments, those that may have been shipped from a dozen different points over as many different railroads, being available for hauling from the universal off-track inbound-depot that the consignee may elect as the facility at which he desires to accept receipt of his shipments.

In St. Louis our company now has eight universal off-track depots; five for the handling of outbound and three for the handling of inbound freight, from and to which less-than-carload St. Louis rates apply, no extra charge being made to shipper or consignee for the movement or handling of freight by our company, the charge for our service being absorbed by the railroads out of their published tariff rates to and from St. Louis. Our facilities thus become in every respect those of the railroads; and, operating as agents for all railroads terminating in St. Louis and East St. Louis, Ill., in the transfer of both inbound and outbound freight between our eight universal off-track depots located on the west side of the Mississippi River and the various railroad freight depots located in St. Louis and East St. Louis, Ill., we have developed a system of automotive transportation that, for practical purposes, places our universal depots "on-track," so to speak, by what amounts virtually to the operation of non-track railroad transportation through the congested industrial sections of St. Louis.

Tremendous Volume of Tonnage Handled

Under this system we handle nearly 7,000,000 lb. of merchandise daily, representing 466 carloads per day, loaded to 15,000 lb. each, or approximately 145,000 carloads per year, and that number of box cars is thereby released for other service. This enormous tonnage, of which 65 per cent comprises that shipped from and destined to St. Louis proper and the remainder that for points beyond St. Louis, interchanged between the railroads terminating in St. Louis and East St. Louis, Ill., is handled more expeditiously and at a lower cost to the railroads, all factors considered, than they could handle it through their rail terminals; and, in addition, on that shipped from and destined to St. Louis, the expense of drayage to shippers and receivers is reduced to a minimum by the convenient location of the universal off-track depots we provide for its handling.

Confronted by the barrier of the Mississippi River, the rail connections of the Eastern lines were built to East St. Louis, Ill., and those of the Western lines to St. Louis, there being no rail connections between these points until the opening of the Eads Bridge for traffic in the summer of 1874. For such rail carriage, the rates on merchandise from and to St. Louis were on a plus basis of 2 cents per 100 lb. more than the East St. Louis, Ill., rates. However, for the more expeditious movement of their business, the majority of St. Louis shippers and receivers teamed or had their consignments teamed between St. Louis and East St. Louis, Ill., which was an added expense.

In 1908, when the St. Louis and East St. Louis, Ill., less-than-carload rates were made the same, the then existing union rail facilities in St. Louis were not adequate to handle the traffic for actual delivery within St. Louis and, as the Eastern railroads terminating in East St. Louis, Ill., could not secure, had they so desired, space in the industrial districts of St. Louis for the erection of their own depots, they entered into an agreement with our company, and another transfer company that was subsequently absorbed by our company, to handle the business. Notwithstanding the fact that they had their own depots in St. Louis, the utility of this arrangement was recognized quickly by the Western roads and they entered into a like agreement for the handling of their business. This had the effect of making us the authorized agent for all the railroads serving St. Louis.

Automotive-Transportation Development

During each succeeding year of operation our hauling methods have undergone a process of studied development. It began with us, of course, with teams, and was changed subsequently in part to motor trucks, but within more recent years we have adopted a form of tractor and semi-trailer automotive-transportation that marks a revolutionary development in the handling of less-than-carload freight within the large industrial city and terminal center of St. Louis.

We found the motor truck to be an improvement over teams in the saving of time, but it did not prove an economical method, due chiefly to the enforced loss of time during the loading and unloading operations. While the speed of the motor truck was considered absolutely essential to meet the growing requirements of our business, it was considered equally essential to find some method that would enable us to use automotive-transportation on an economical basis. Thought was turned to the semi-trailer idea, just as in river transportation the thought in recent years has been along the line of towboats and barge service in order that the heavy investment in steamboat machinery might not be idle during the long time taken for loading and unloading. The cost of operating a railroad for freight purposes, for instance, would be prohibitive were it found necessary to tie up in idleness a locomotive every time a box car was loaded or unloaded.

A search of the market failed to disclose a semi-trailer entirely practicable for the purpose of our operation. There were various types of tractor and semi-trailer successful enough when the operation was limited to pulling, but wholly impractical in operations requiring accurate backing-up, frequently under difficult conditions, such as constantly confront the receipt and delivery of freight at the platform of a railroad freight depot. The difficulty with the semi-trailers to be had was the ab-

sence of any method of controlling the steering of the semi-trailer in reverse operation. Therefore, steps were taken to design a semi-trailer that would overcome this disadvantage.

Four years ago it was found that, with a few minor changes, a certain semi-trailer could be constructed so as to meet our requirements fully. We began, as an experiment, with one tractor and three semi-trailers and the trial proved so successful, practical and economical that 4 additional tractors and 12 additional semi-trailers were ordered immediately. Upon further experiment, we determined upon a policy of displacing our teams and truck equipment with tractor and semi-trailer equipment as rapidly as circumstances would permit. At that time we had in service 600 horses, 350 stake wagons and 72 motor trucks with a capacity of 5 tons each. As against 5 tractors and 15 semi-trailers in use 2 years ago, we now have in operation 56 tractors and 168 semi-trailers, with some of the teams and motor-truck equipment yet to be displaced, as 200 wagons and 55 motor trucks are still being

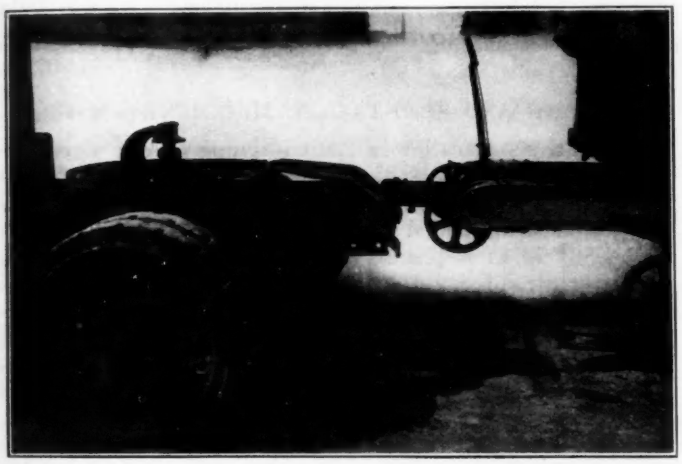

FIG. 1—COUPLING DEVICE EMPLOYED TO CONNECT THE TRACTOR AND THE SEMI-TRAILER

operated and 17 of the 72 motor trucks operated 2 years ago have been converted into tractors at our own shops.

Tractor and Semi-Trailer Operation

Not being an engineer, I am unable to give a technical description of the semi-trailers we used, but I shall endeavor to describe briefly how they work and point out their utility and adaptability in the transportation of merchandise. For efficient operation they should be loaded dead; that is, the tractor during the loading and unloading of semi-trailers should be engaged in the hauling of other semi-trailers under load. Each semi-trailer stands as a unit on four wheels while being loaded and unloaded and, when ready to move, the coupling of tractor and semi-trailer is done instantaneously and automatically, being controlled by the chauffeur while in his seat in the cab. The same operation automatically releases the brakes and elevates the front-end supporting-wheels of the semi-trailer, the load in motion thus being on six wheels, the four wheels of the tractor and the two rear wheels of the semi-trailer. These semi-trailers are equipped with internal expanding drum-brakes that automatically control them while in process of coupling or uncoupling with the tractor, as well as preventing them from over-running the tractor when descending a grade or making a stop on the level. The coupling of tractors and semi-trailers is illustrated in Figs. 1 to 3, showing the equipment in our service. Fig. 1 shows the coupling

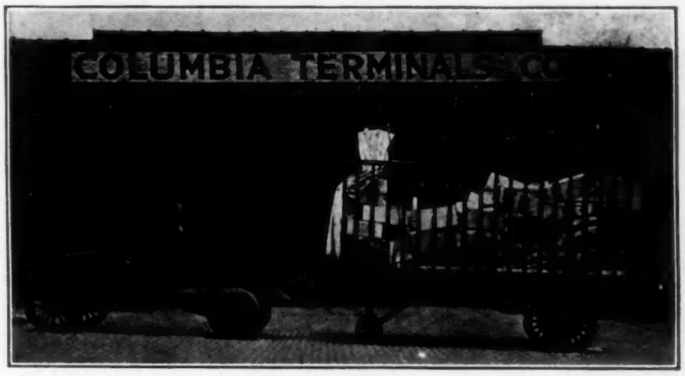

FIG. 2—A TRACTOR AND A SEMI-TRAILER ABOUT TO BE COUPLED

device of a tractor and a semi-trailer; Fig. 2 illustrates a tractor and a semi-trailer about to be coupled; and Fig. 3 is a view of the tractor and the semi-trailer when coupled.

During the operation, the tractor chauffeur remains in his seat; the coupling is done automatically. The tractor, backing-up, lifts the front end of the trailer by engaging the guide wheel with the mounting tracks, then locks the trailer to the fifth-wheel coupling-device on the tractor chassis. The same operation automatically releases the brake and elevates the supporting wheels of the trailer. The whole operation can be reversed by pulling a lever in the chauffeur's cab.

Experience has proved to us the advantages of the semi-trailer over motor trucks operated under similar conditions. Our records show that the average daily mileage of our 5-ton motor-truck was not over 20 miles and, moving at 10 m.p.h., which is about the limit of speed that can be maintained on frequented city streets, they were in actual productive service only 2 hr. daily, the other 6 hr. of a business day being consumed in their loading and unloading operations. By operating on one tractor to three semi-trailers, one semi-trailer is being loaded, one is being unloaded and one is in transit, except that we unload semi-trailers alive at the outbound railroad-depots to check the delivery of each shipment and get a proper receipt thereon. The idleness of the tractor, which represents the considerably heavier portion of the investment, has been reduced by us to a minimum.

Off-Track Station Construction

When we decided to standardize on semi-trailers, we proceeded as rapidly as possible to fit that class of equipment to our business and our business to that equipment.

FIG. 3—THE TRACTOR AND THE SEMI-TRAILER COUPLED TOGETHER AND THE AUXILIARY FRONT AXLE AND PAIR OF WHEELS OF THE LATTER RAISED

Our facilities were originally built for the handling of business by teams, and it was necessary to make alterations in some of them so as to afford the full measure of economy in the use of semi-trailer equipment. As new facilities are built, the best points obtainable from a thorough survey of modern freight terminals are being incorporated in their construction, together with improvements suggested by our experience in the operation of tractor and semi-trailer equipment.

To give an idea of the plan of construction of new facilities, the Sixth street inbound-depot building is 30 ft. back from the building line on Sixth Street and 15 ft. from a public alley on the west, permitting the dropping of trailers on either side and of their being unloaded there dead without interference to pedestrians or vehicular traffic. Loaded semi-trailers are dropped, those containing mixed shipments being unloaded on the platform for delivery to the various consignees. Straight loads and large lots for one consignee are left on semi-trailers and delivery is made therefrom to the vehicle of consignee.

Fig. 4 illustrates the 11th Street outbound depot and semi-trailers in process of loading. This depot is constructed with a view toward affording across-platform movement of freight; that is, the handling of consignments from the shipper's vehicle across the depot platform to semi-trailers. Frequently, shipper's vehicles pull alongside of semi-trailers and the transfer of shipments is made direct from one vehicle to the other. An outstanding feature of this depot is its immense paved driveway, 60 ft. in width and extending through the entire block length of the structure. This driveway is intersected at the middle by a 40-ft. paved-driveway between the two units of the building, making available for the use of shippers, in the delivery of their outbound freight, four immense platforms having an aggregate length of 740 ft. and being 30 ft. wide, a width determined upon as contributing best to the expeditious handling of freight.

This depot is operated on the four-dump plan, each one of the platforms being set aside for the receipt of freight for a specified group of railroads. Thus, while the depot is universal and receives freight for all railroads, this plan of operation permits the greatest possible dispatch in handling outbound freight, reducing to a minimum the time required for the passage of freight through the depot to our equipment, and thence to the railroad that is to transport it to its final destination. Shipper's vehicles make delivery to the platforms on the inside of this depot, and shipments are trucked across the platform to waiting semi-trailers that are loaded simultaneously. Semi-trailers loaded at this depot are usually straight loads for one railroad; that is, while the load may consist of anywhere from 1 to 100 shipments, from perhaps as many shippers, they are all for movement over the same railroad. At our smaller off-track outbound depots, it is not always possible to confine the loading of each semi-trailer to consignments routed by way of one railroad without holding shipments until a capacity load is accumulated. This would impair the service to our patrons by delaying the delivery of shipments to the railroad and, in these circumstances, shipments for two or more railroads are loaded on a semi-trailer. When it is necessary for us to load shipments for two or more roads on a semi-trailer, it is reflected in an increase in our hauling cost per ton.

Handling Semi-Trailers at Railroad Depots

At outbound railroad-depots, semi-trailers are unloaded alive to check the delivery of each shipment and get a proper receipt thereon. At inbound railroad-depots a supply of semi-trailers sufficient for their requirements is placed daily at the platforms of most of the depots in East St. Louis, Ill., our representative giving a receipt to the railroad for each shipment as it is loaded and, as each loaded semi-trailer is pulled from the depot platform during the day, an empty one is immediately dropped in its place, thus making our semi-trailer equipment always available for loading. We are extending this service to the other railroads as fast as new semi-trailer equipment is received.

This ever-ready supply of our semi-trailers is particularly advantageous to the railroads, as the trailers practically increase the depot platform area and, because of their availability, this permits the transfer of merchandise shipments direct from freight cars thereto, thus effecting a material reduction in the railroad labor cost of handling per ton. In this respect our semi-trailer has a distinct advantage over removable truck bodies, in that they occupy driveway space adjacent to the depot platform; whereas, removable truck bodies occasion an excessive demand upon platform space which is the most valuable and the most urgently needed space about a freight depot.

Tractor and Semi-Trailer Movement-Control

When a semi-trailer is loaded at one of our universal outbound depots, it is picked-up by a tractor and moved to the on-track outbound-depot of the railroad and, after it has been unloaded there by the chauffeur and his helper, it is then placed at the inbound-depot platform of the railroad for reloading and the tractor proceeds to pick up another loaded semi-trailer. The distribution of tractors for the hauling of loaded semi-trailers, and the placing of additional light semi-trailers for loading during the day at depots where they may be needed at the time, is controlled from our general office through an efficient dispatching system. We have a dispatcher in East St. Louis, Ill., and a chief dispatcher in St. Louis; each semi-trailer is reported to them as soon as loading is completed.

As each tractor chauffeur leaves a depot with the first loaded semi-trailer in the morning, the depot so reports to the dispatcher in St. Louis or East St. Louis, Ill., according to the location of the depot from which the start is made, giving the name of the chauffeur, the tractor number and the depot to which the load is destined. This information is immediately exchanged between the dispatchers, whereupon the chief dispatcher makes up a daily operating card for each tractor chauffeur, upon which is recorded his operations currently throughout the day; information thereon being telephoned over a private wire to the dispatchers by the depots. These daily operating cards are kept by the chief dispatcher according to the district to which tractor chauffeurs have loads, so that he may know at all times each and every tractor that is en route to each depot in each district. The location of every tractor and semi-trailer being thus at all times definitely known to the chief dispatcher, when a semi-trailer is loaded and ready to be moved, or when an empty semi-trailer is needed at any particular depot, he can place his hand on the tractor, so to speak, and assign it to the required service without delay.

Weight and Protection of Loads

The average loading of our semi-trailers is 12,000 lb. which, on outbound loads, consist on an average of consignments from 20 different shippers and, on inbound loads, shipments for 25 different consignees. In the con-

solidation thereof on our 9-ton-capacity semi-trailers, congestion at on-track depots is avoided by the reduced number of vehicles they have to serve at their platform doors. Street traffic is also reduced by the displacement of individual conveyances of small capacity in the haul between the shipper and the railroad. We use on our semi-trailer equipment a stake wagon-body 8 ft. x 16 ft. with a waterproof canvas cover, known as a "house top," which is spread in bad weather for the protection of shipments. Fig. 5 shows a loaded semi-trailer with the "house top" spread.

We have found that this cover, when properly adjusted, affords ample protection to the load under all weather conditions, the instances of damage to shipments by bad weather being negligible. In fact, damage to shipments from all causes, those sustained in our depot handling as well as while in transit on our vehicles, for a period of 3 years was, on outbound traffic, but 0.0027 per cent and, on inbound business, 0.0031 per cent of the revenue earned. As compared with a closed body, the stake body affords more elasticity and density of loading as well as avoids the stifling heat of which labor complains in the loading of closed bodies during the summer months.

Distance of Haul and Economy of Operation

The distance of haul between our universal off-track depots and the on-track depots of the railroads on St. Louis merchandise, and between the on-track depots of the railroads on interchanged shipments destined to points beyond St. Louis, is from 1 to 3 miles; between these facilities, an average of from 60 to 75 of our vehicles under load are in transit every hour throughout the day.

By the use of tractor and semi-trailer equipment, we have accomplished the greatest aim in efficient hauling; that is, a reduction in the hauling cost per ton. As compared with motor trucks in similar service, by the use of tractor semi-trailer equipment the cost per ton on our hauling operations has been reduced 50 per cent.

The principal advantages in the use of tractor semi-trailer equipment that have contributed thereto can be summed up briefly as follows:

(1) A larger quantity of freight is transported on each load, as a 3-ton tractor can pull a 9-ton loaded semi-trailer

(2) One tractor serves for three carrying units, each one of treble the ordinary capacity

(3) Constant production by the major part of the investment represented in the tractor because of its not standing idle during the process of loading and unloading

(4) Waiting semi-trailers, enabling uninterrupted and diversified loading

(5) Saving of valuable depot-platform space because of the ever present loading facilities provided by the semi-trailers

(6) Decrease in insurance due to the absence of fire hazards, as semi-trailers loaded with merchandise are parked overnight in buildings containing other merchandise, with no increase in insurance on building or contents. This is not possible with motor trucks, as the presence of fuel therein creates a fire risk that most insurance companies will not underwrite

(7) Decrease in garage space, it being necessary to keep in a garage only the tractors, the average overall length of which is 12 ft. each; empty semi-trailers do not require housing.

(8) An avoidance of idle time for a chauffeur, because a loaded semi-trailer is ready when he reports in the morning. He couples his tractor thereto and proceeds with the load; in like manner he is continuously engaged throughout the day

Fig. 4—One of the Outbound Freight Depots and a Number of Semi-Trailers Being Loaded

Selling Transportation

Tractors and semi-trailers are now used in the transportation of intra-terminal merchandise at several cities other than St. Louis, but their possibilities in that service, as well as their use as a means of effecting economies in the performance of other service that the railroads are now rendering, are not realized fully by those most interested, the builders and operators of automotive equipment. This applies also to the extension of the use of automotive equipment in commercial hauling.

Producers and operators of automotive equipment will come to realize the possibilities of automotive transportation when they sell transportation that fits the requirements of the service in which it is to be used and that opens a field for "transportation engineers," men who, through experience, are competent to analyze each hauling problem as it is presented.

The character of the commodity to be transported, the loading and unloading facilities, the size and weight of loads, the distance of haul, the number of points of delivery and the highway conditions, are a few of the primary factors that the transportation engineer must study and analyze before deciding on the automotive hauling unit best fitted for a particular service.

The motor truck of today has its place in transportation from which it cannot be displaced but, due to its construction, it has its limitations as an economic hauling unit. Automotive equipment involves investment maintenance, depreciation, chauffeur's wages, garage rent and

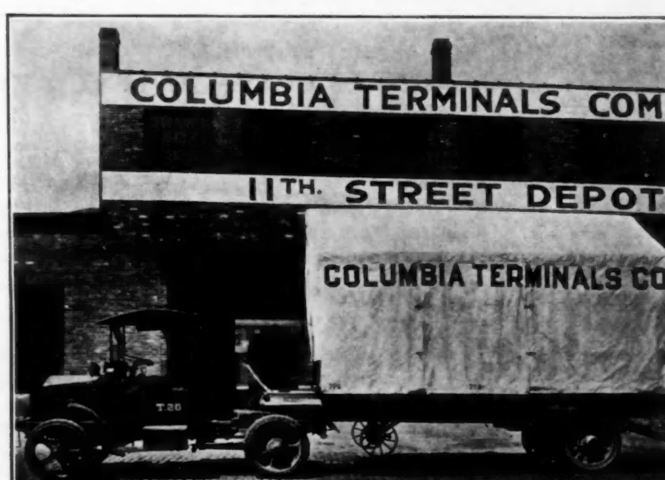

Fig. 5—A Loaded Semi-Trailer with the "House Top" Spread

various other overhead expenses. All of these items represent a loss in proportion to the idleness of the investment, the major part of which is in the engine; it follows, therefore, that in proportion to the reduction of the idleness of the engine there is an increase in the efficiency, with a decrease in the hauling cost per ton. The engine being an integral part of a motor truck, it is impossible to eliminate its idleness; whereas, with semi-trailers, it is possible to do away with engine idleness during loading and unloading and this should result in a decrease in the hauling cost per ton. Moreover, two-thirds of the hauling power of an engine is wasted when it is used as a carrying unit, as in the case of a motor truck. On the other hand, semi-trailers afford a means of overcoming lost time and lost capacity, with a corresponding reduction in the investment, as one tractor and three semi-trailers represent only one-half the investment in three motor trucks.

The field for the more extensive use of automotive transportation has many possibilities, some of which I know are now being given close study. The more important benefits are summarized as follows:

(1) In the correlation of railroad and automotive transportation is afforded the solution of adequate terminals in large cities as has been demonstrated in St. Louis

(2) Less-than-carload traffic interchanged between railroads at terminal centers can be handled more economically by automotive transportation than by rail carriage

(3) Universal off-track depots, which can be constructed in industrial districts within large cities at locations that would be inaccessible if not prohibitive by the cost of the right-of-way to reach them by rails, serve the railroads and the business community better than would on-track depots

(4) In the correlation of railroad and automotive transportation, the use of tractor semi-trailer equipment improves the service and reduces the hauling cost per ton

(5) The extension of automotive transportation as an efficient hauling medium, in conjunction with the railroads and in commercial service, depends upon how well the equipment is fitted to accomplish the service for which it is to be used

RECORD PRODUCTION OF PORTLAND CEMENT

ONE of the most impressive features of the year 1922 in an economic sense was the unparalleled activity of the cement industry in the United States with its record-breaking figures for the year's production and consumption of Portland cement. These phenomena were, of course, entirely in harmony with the exceptional scale of building operations and of road-building and other construction work in the Country during the past 12 months; but none the less it is a very striking fact that the cement industry alone among the major industries of the United States should have experienced in 1922 far and away the best year in its history. According to the statistics of the production, shipments and stocks of Portland cement that are compiled monthly by the United States Geological Survey, under the direction of G. F. Loughlin, the total production in 1922 was 113,870,000 bbl., as compared with 98,293,000 bbl. produced in 1921, an increase for 1922 over 1921 of 15,577,000 bbl., or 15.8 per cent. Up to 1922, the record year for Portland cement production in the United States was 1920, with a total output of 100,023,245 bbl.; but this output was exceeded in 1922 by approximately 13,847,000 bbl., or 13.8 per cent.

Perhaps even more remarkable than the 1922 production of Portland cement were the year's shipments from the manufacturing establishments, such shipments, of course, roughly measuring the year's consumption. The 1922 shipments totaled 116,563,000 bbl., as compared with 95,051,000 bbl. shipped in 1921, the gain in shipments in 1922 compared with 1921 being 21,512,000 bbl., or 22.6 per cent. It further appears from the figures that the shipments of Portland cement in 1922 exceeded the year's unprecedented production by 2,693,000 bbl., with the result that the stocks at manufacturing establishments at the end of the year were smaller by this amount, equivalent to 23 per cent, than they were at the end of 1921.—*Economic World.*

THE PRODUCTION ENGINEER

MANUFACTURING conditions have changed greatly in the last decade, and during this period labor costs have increased considerably. It, therefore, is more necessary than was the case in the past for every effort to be made to place production on a scientific basis and to raise the status of those persons who are directly responsible for manufacture.

There is no doubt that the successful executive in industry must be a person of good education. An educated mind, capable of logical thought and with orderly mental processes, is an essential in any position of responsibility. To this must be added a full and thorough knowledge of both engineering design and the principles of efficient production.

Too much importance cannot be attached to the training of apprentices and young engineers generally. Five years' practical experience in the workshops is not a day too long for any youth who desires to master the rudiments of modern engineering production, which tends to become more and more complicated.

A phase of engineering education that appears to be almost entirely neglected is that relating to knowledge of organization and administration. Apart from technical literature, such as periodicals and books by specialists, the younger generation of engineers is offered no tangible means of obtaining an insight into such matters as efficient procedure in the cost office, purchasing department and similar sections of the modern works. Practical experience of these departments is of prime importance, but as a general rule it is extremely difficult for apprentices to get any definite instruction on the matters mentioned above.—*Engineering Production* (London).

The Engineering Aspects of Traffic

By William P. Eno[1] Washington Section Paper

The author outlines general and special highway-traffic regulations with regard to their application, stating that the general regulations, which have been codified, should be standardized, and that as many as possible of the special regulations should be made uniform as time elapses. Among the engineering problems mentioned are the cutting-off of street corners on a proper radius, the location of car-tracks, the widening of streets, the relation of the streets to the width of the sidewalks and their capacity to carry a given number of lines of vehicles without wasting space. Other subjects for engineering effort include the design of street intersections for new streets, the location of lights, trees and culverts, and the reformation of streets that were laid out before any thought was given to street-traffic regulations. References are made to more lengthy discussions of the subject.

Although it had been apparent for 10 years or more to the few who were then making a study of traffic regulation that the engineering side of traffic was bound to be of supreme importance in the future, it was not until 1914 that the attention of the general public was attracted to this point through an article entitled The Science of Street Traffic.[2] In referring to the fact that street-traffic regulation had existed for only about 10 years, the article said: "Since then the advantages of regulation have become so apparent that civil engineers are turning their attention to the problem and are making a profession of it."

It is beginning to be realized that the police department or boards of aldermen of the various cities and towns should not be allowed to make their own general highway-traffic regulations, because this practice has resulted in confusion and lack of uniformity, bringing about a much larger number of accidents than would have been the case had the regulations been the same all over the Country.

General highway-traffic regulations are those that are suitable for the largest city, but they contain nothing superfluous for the smallest village, and these are the only regulations that any attempt should be made to standardize. They have been condensed into a code which is now known as the Council of National Defense Code of General Highway-Traffic Regulations. They are short because, if they were not, people would not read them. They are reasonable, else they could not be enforced. The last resort of anything in any free country is public opinion, and, if public opinion does not make a law enforceable, that law becomes a detriment and not an advantage to the Country. The Council of National Defense Code has been compiled by students of traffic regulation, many of whom are engineers of distinction, and any future revisions of the code should be made under the direction of similar minds.

Special regulations also should be worked out by technical men, and as many of these regulations as possible should be made uniform as time goes on. Absolute uniformity is, however, impossible in special regulations; therefore, much of the work must be done through police departments. But here, again, the officer in charge of traffic should be selected for his natural traffic-engineering ability, open-mindedness and willingness to study and experiment in order that he may be able to give the best results to his town.

Engineering Problems

The things that are essentially engineering problems begin, perhaps, with cutting off the corners of the streets on a scientific radius instead of by rule of thumb. The locating of car-tracks needs expert study, as do the widening of the streets, their relation to the width of the sidewalks and their capacity to carry a given number of lines of vehicles without wasting space.

The rotary system holds out all sorts of advantages and is probably the most valuable system that has been devised for the regulation of traffic; it can solve many problems that nothing else can. The laying-out of new streets requires much thought and consideration to decide exactly how their intersections should be designed. The matter of the location of lights, of trees and of culverts is of great importance, but this is not a difficult problem if one keeps in mind the fact that trees, lights and culverts should not be placed so as to interfere with the best location of the crosswalks.

We have also the problem of the streets that were laid-out before any thought was given to street-traffic regulation and have lamps, trees and culverts placed in unfortunate positions. These conditions need careful study and the ability to make the best of a bad bargain. The super-elevation of roadways is now at last scientifically begun, and the cross-sectional slant of the roadway to the curve of the road in relation to speed should be encouraged as tending to reduce wear-and-tear on both the road and the vehicle and to increase safety greatly.

I have mentioned only a few of the more important details, confining myself rather closely to my own branch of the work, the handling of vehicular and pedestrian traffic, and not pretending to be competent to discuss with any degree of assurance many of the other branches of engineering work in relation to the problems in road and vehicle construction that form part of this perhaps most important subject of our generation, highways transport. As we all know, highways transport has now passed the railroads in money investment and within a short time may perhaps double that great sum.

By way of caution, in the selection of engineers for civic traffic structural problems, the many mistakes made in the past by those entrusted with such work must be kept in mind to avoid a repetition of such costly blunders in the future.

In the introduction of the first book on traffic[3], the following was said:

> Unless the height of buildings is regulated by law, or by taxation in proportion to their height, or by a combination of the two methods; unless a complete plan for underground rapid-transit, sewers and pipe galleries be adopted before more obstructive subway work is undertaken, no street-traffic rules or regulations or enforcement of them can possibly provide for the natural increase of surface traffic, either on the

[1] Chairman of the board of directors of the Eno Foundation for Highway-Traffic Regulation, City of Washington.

[2] See *World's Work*, February, 1914, p. 398.

[3] See Street-Traffic Regulation, by William P. Eno.

sidewalks or on the roadways of New York City. What would have cost practically nothing but a little forethought a few years ago, will now require tens and, if continued, hundreds or perhaps thousands of millions of dollars eventually. It is the old story of a "stitch in time saves nine"; it is also a serious reflection on the intelligence of the citizens of New York City that they have not sooner taken sufficient interest in these matters of civic government and, by blotting out corrupt politics and appointing decent men, running their city on business principles, avoided such costly blunders.

Other details as to the engineering aspects of traffic can be found in a book[4] published in 1920. These references are given as time will not permit a more lengthy discussion of this complicated subject.

[4] See the Science of Highway-Traffic Regulation, by William P. Eno; particularly Parts 5 to 9 inclusive.

HIGHWAY AND TRAFFIC RECOMMENDATIONS

SOME of the recommendations made by T. J. Wasser, State Highway Engineer of New Jersey, and president of the American Road Builders' Association, in an address before the Thirteenth American Good Roads Congress, Chicago, Jan. 16, 1923, are of interest to the members. These recommendations were that

The minimum graded-width of all main highways be not less than 30 ft.

This graded-width be kept clear of all encroachments.

All traffic rules be made uniform.

A system of marking one-way streets be adopted, which will be uniform as to the type and the location of the markers.

It is desirable to standardize all directionary and cautionary signs as to their color and marking, and that posting signs other than directionary and cautionary on the right-of-way be made unlawful and subject to a fine for each offense.

The erection of signs on property abutting on the highway at curves, railroad crossings and intersections be discontinued, where such signs would obstruct the view of those using the highway.

It is desirable to standardize the colors to be used for the degree of danger where illuminated signs are used; for instance, red at a railroad crossing or dead ends of highway, green for highway intersections and amber for grades and curves.

A uniform traffic-regulation be adopted for intersecting highways to be in effect in the absence of traffic officers.

A uniform maximum-height, width and length of vehicle be adopted.

A uniform gross-weight of vehicle and load for each class of commercial motor vehicle be established.

All gas-filling stations be located on property abutting on the highways, and not on the right-of-way; and all such stations shall display a visible tag on each pump, which shall be placed there by the State Department of Weights and Measures certifying as to the accuracy of said measuring device.

The parking of vehicles on both sides of a highway opposite each other, where a minimum distance of 20 ft. between the vehicles is not provided, be considered a nuisance and be made punishable by a fine.

The erection of all booths and stands for the sale of goods, as well as the displaying of farm produce in containers, within the right-of-way be prohibited, and also the use of vehicles for retailing wares along the highway where such practice would cause persons to congregate on the paved portion be prohibited.

A uniform penalty for operating a defective motor-vehicle on the highway be provided, it being alleged that tail-lamps frequently fail to function due to the wires having been damaged by abrasion or exposure to splashing water, and broken or improperly adjusted brakes and badly worn tires being mentioned.

Legislation be enacted to provide against motorists running past barricades on roads under construction and destroying unfinished work.

Sidewalks be provided for the use of pedestrians along the highway adjacent to built-up communities.

Pedestrians using the highways in the open country shall walk to the left and that operators of all vehicles drive to the right.

When one-piece shipments that exceed the maximum weight-allowed by law are made, they shall be shipped on specially built vehicles designed to distribute the load in a manner consistent with legal requirements; and only after obtaining permission from an authorized source.

Uniform distinctions be made between maintenance, betterment and reconstruction in order that comparisons may be made.

Motor-vehicle taxation or license-fees be not greater than are required to provide the sum necessary for the maintenance of the highways.

Overloaded trucks operating on the highways be seized and held for a period of not less than 5 days, stored at the owner's risk and expense and the owner fined.

Hauling companies who contract for shipments by the ton, when caught overloading their vehicles, should have their license revoked, in addition to any other penalty.

All operators of motor vehicles be licensed, and prohibited from operating a vehicle for more than 12 consecutive hr., to be followed by an 8-hr. rest.

In addition to any uniform motor-vehicle law previously recommended, all applicants for a driver's license or a renewal thereof be required to submit a physician's certificate bearing a date not more than 1 month earlier than the date of the application. This certificate should be accepted only from designated physicians, and be to the effect that the applicant is in fit mental and physical condition to operate a motor vehicle.

The examination for a driver's license include the testing of ability to read and write English, and that a license be granted only to citizens of the United States, with provisions for tourists from other countries.

The owners of all motor-vehicles must carry liability insurance for each vehicle operated.

All vehicles, both motor and horse-drawn, be equipped with clearance light visible from the front and the rear; this light to be of a shape other than round, located on the extreme left side of the vehicle or load if over width, and showing green in the front and red in the rear.

Stop and Direction Signals for Motor Vehicles

By R. N. Falge[1] and W. M. Johnson[1] *Illustrated with* Photographs and Drawings

Traffic congestion, the growing popularity of closed cars and the increasing number of motor vehicles used in winter driving are some of the reasons for the insistent demand for electrically lighted stop-signals, which, being entirely automatic in operation, require no thought or action on the part of the driver. No less than 14 automobile companies are now installing such signal systems as initial equipment on their product, and a number of States have passed laws making the use of some form of mechanical or electrical signal compulsory where arm-signalling is impracticable. The advantages of such legislation as a means of promoting safety to both driver and pedestrian are so apparent that there is little doubt that similar action will be taken by other States where the matter is now under consideration. Unfortunately, however, not all of the many signal equipments placed upon the market have received the careful attention in design and construction necessary to insure consistently satisfactory performance. The field has been a new one; in many cases design has been undertaken without sufficient technical information. It is the purpose of this article to analyze the requirements of a satisfactory signal and to suggest improvements.

Typical Signals

The simplest form of signal and the one in most common use today, is the so-called *Stop* signal illustrated in the upper left corner of Fig. 1. This simply indicates that the driver of the car carrying the signal is applying his brakes and slowing-down. The signal is operated automatically; probably the most common form of control is by the brake pedal. This automatic control relieves the driver of the necessity of extending his arm or of manually operating a signalling device when making a stop, which is often so sudden as to require his entire attention.

For initial installation by the car manufacturer, the *Stop* signal is often combined in one housing with the tail-light as shown in lower left corner. This combination gives a unit of pleasing appearance and at the same time the cost is less than for two separate devices. The two units operate independently of each other. Another arrangement is the combination of a *Stop* signal with a parking lamp in one housing. This is somewhat similar to the combined *Stop* signal and tail-light mentioned above.

A modification of the simple *Stop* signal is one that indicates either *Slow* or *Stop,* and is illustrated at the right hand upper corner. The *Slow* warning is lighted when either the clutch or brake pedal is depressed and the *Stop* replaces the *Slow* when both pedals are depressed. The results obtained with this type of signal depend in large part upon the driver's habits. For example, some drivers in wet weather, apply the brake without releasing the clutch until just before the machine comes to a full stop; the resulting indication is very different from that given by the driver who presses both brake and clutch pedals simultaneously. The result is that both *Slow* and *Stop* must be considered warnings of equal value.

Fig. 1—Typical Stop and Direction Signals

That in the Upper Left Corner Is Perhaps the Most Generally Used Form of Stop Signal and Underneath Is a Combined Stop Signal and Tail-Lamp. The Device in the Upper Right Corner Is a Combination Slow and Stop Signal, While Directly Underneath Is a Two-Color Signal That Indicates Whether the Throttle Is Opened or Closed and at the Lower Right Corner a Signal That Indicates the Direction of a Contemplated Turn as Well as the Application of the Brakes Is Illustrated

Another type of signal, shown at right center, indicates whether the throttle is open or closed. This signal contains two lamps controlled by the accelerator pedal. When the pedal is depressed, a green signal at the rear is lighted, and when it is released the green is turned off and a red signal turned on. A disadvantage of this type of signal is that there is a continual drain on the car battery, for one lamp or the other is lighted all the time the car is in motion. The laws of a few States, moreover, permit only red, yellow or white lights to be carried on motor vehicles.

The *Stop* signal, while of great value, does not in all cases give a complete indication of the driver's intentions. It is desirable that when a turn is contemplated, a signal of the intended direction be given to the driver of the car following. This is readily accomplished by

[1]Engineering department, National Lamp Works of the General Electric Co., Nela Park, Cleveland.

FIG. 2—DIFFUSION OF BRIGHTNESS AND SPARKLE OVER THE LENS SURFACE DEPENDS UPON THE TYPE OF REFLECTOR EMPLOYED

The Inside of the Housing at the Left Is Coated with White Enamel, a Silver-Plated Reflector with an Improper Contour Is Used with the Middle Signal and at the Right a Silver-Plated Parabolic Reflector with the Lamp Properly Placed at the Focus Is Used. A Comparison of the Three Views Indicates That While the Light Is Diffused in the Left-Hand Signal, There Is No Sparkle Except Directly from the Lamp Filament; in the Middle View the Brightness and the Sparkle Are Uneven and Are Confined to a Portion of the Lens Surface; and at the Right an Even Illumination with a Uniform Sparkle Is Obtained

the combination *Stop* and *Direction* signal, shown in the lower right corner. Arrows, illuminated by lamps within the housing, indicate the direction of the intended turn. These may be combined in one unit, as shown, or may be separated; an arrow is sometimes mounted on each rear fender.

The problem of designing a method of control for a signal that will indicate a contemplated change of direction is much more complicated than for a *Stop* signal alone. Systems of switch control that are actuated by the steering mechanism operate too late to be of any great value to the driver of the car in the rear. It is

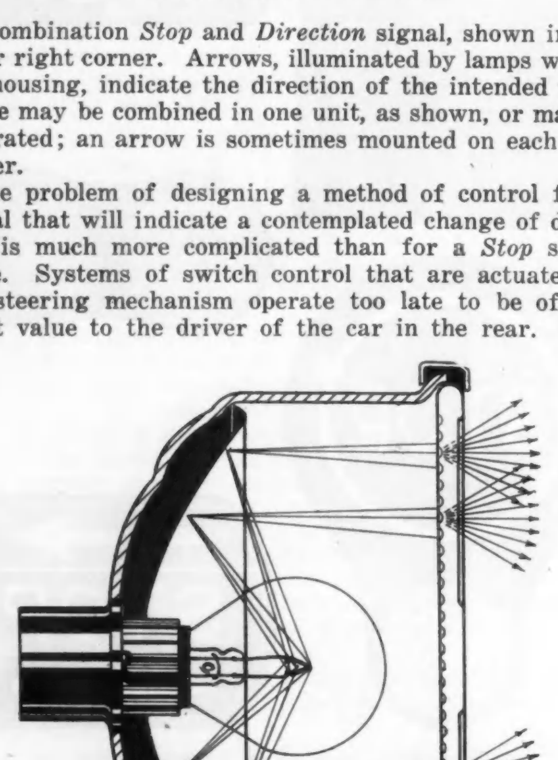

FIG. 3—LIGHT CONTROL IN A STOP SIGNAL OF GOOD OPTICAL DESIGN

desirable that even manually operated switches be turned off by some automatic means, thus relieving the driver of the necessity of attending to this detail. Considerable attention is being given to the problems which a direction signal presents and improvements in the switching devices are constantly being made.

The early types of signal were often the creations of incompetent designers and evidenced inferior workmanship; their only claim to merit was low price. They are being gradually replaced by units which function more effectively and with entire reliability.

The *Stop* signals of today are most often mounted on the left rear fender. For best appearance, the top of the housing is usually placed level with the top of the fender.

IMPORTANCE OF INDICATOR OR TELL-TALE

The driver installs a warning signal in order that his intentions will be made known to traffic without conscious effort on his part. He soon learns that his signal operates effectively and grows accustomed to relying entirely upon it. For this reason, it is of the greatest importance that some means be provided which will inform him unfailingly every time he uses his signal that it is operating properly. This assurance is obtained by a small indicator-lamp, placed on the instrument-board or dash in view of the driver, which flashes or lights every time the signal operates. In recognition of the importance of an indicator, the Connecticut law now requires that a device of this kind be provided with electrically lighted rear signals. In the event of a damage suit arising from a collision, the driver's position is materially strengthened if he is sure that his warning signal was operating properly.

CHARACTERISTICS OF A SATISFACTORY SIGNAL

A signal device to give complete satisfaction should have the following characteristics:

(1) Be sufficiently bright to compel attention in the daytime
(2) Not cause glare at night which is so great as to interfere materially with the vision of the driver of the car behind
(3) The switching device should operate so that the signal indicates the intentions of the driver of a change of speed or direction, or both, before any change has taken place
(4) It should be provided with some form of reliable indicator device to keep the driver informed that it is working
(5) Since the prime function of a signal device is to promote safety, it should be reliable. A minimum of attention should be required to keep it in operating condition
(6) Any parts requiring replacement should be readily available

ESSENTIALS OF SIGNAL-SYSTEM DESIGN

For the signal, the 21-cp. headlight lamp now used on all cars is recommended. The highly concentrated filament is adapted to use with the reflector and lens combination employed in signal devices; its brightness is sufficient for the purpose and this brightness is, moreover, maintained throughout the life of the lamp. Since this lamp is standard for headlights, a spare is usually available in the driver's kit. Although satisfactory signals employing either single or double-contact sockets are manufactured, the single contact is preferred because under the limitations of available space better socket construction is possible, and because the car frame, which acts as the return circuit, has a very low resistance. Moreover, when the single-contact socket is used, the signal lamp and the standard headlight lamp are in general interchangeable.

For the indicator, the 2-cp. lamp of the type used for lighting the instruments is recommended. This lamp provides sufficient light for the purpose, consumes but

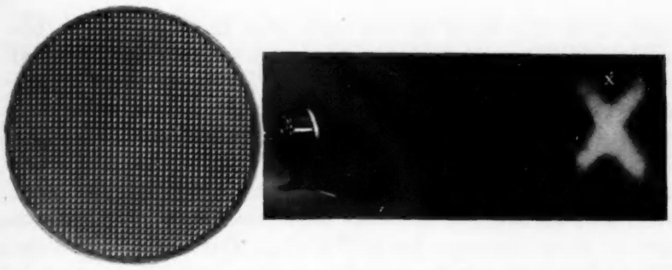

FIG. 4—LENS WITH SMALL PYRAMID-SHAPED PRISMS AND THE CROSS-SECTION OF THE BEAM FROM THIS LENS WHEN THE PROPER LAMP AND REFLECTOR ARE USED

little energy, is interchangeable with other lamps on the car, and is a standard lamp regularly carried in stock. The double-contact socket facilitates proper connection in the circuit.

To provide effective illumination for daytime signalling it is necessary that as much of the light from the lamp as possible be confined within the angle in which it is intended that the signal attract attention. It is essential that an efficient reflector be provided behind the lamp not only to redirect and thereby utilize the light rays from the lamp that are not initially directed toward the cover glass, but also, as will be observed from a comparison of the three views in Fig. 2, to provide a uniform sparkle over the entire lens face. White enamel on the inside of the housing acts as an efficient reflector, but light rays striking it are diffused, giving the lens a lifeless appearance except for the sparkle over a small area in line with the lamp filament. The appearance as well

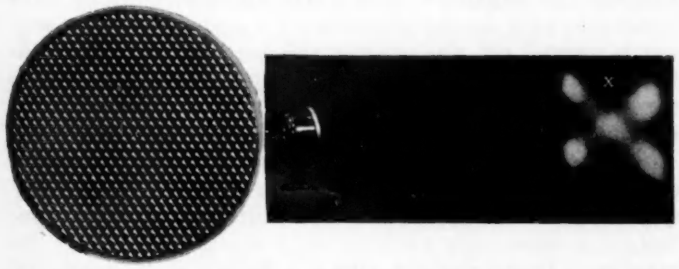

FIG. 5—LENS WITH SMALL DIAMOND-SHAPED PRISMS AND THE CROSS-SECTION OF THE BEAM FROM THIS LENS WHEN THE PROPER LAMP AND REFLECTOR ARE USED

as the effectiveness of the signal may be improved through the use of a reflector with a highly polished surface so designed as to make it possible to reflect images of the filament but slightly less brilliant than the filament itself to every portion of the lens face; by proper lens design, sparkle over the entire face of the lens is obtained. The method most commonly employed and a very effective one, is that illustrated in Fig. 3, in which a highly polished parabolic reflector is used to redirect the rays from the filament in such a manner as to cover the entire lens surface; the lens, in turn, redirects the rays so that a bright spot is visible from each small irregularity from any point within the angle required. The surface of the reflector should have a high reflection-factor and be capable of retaining a high polish. In Table 1 are given the reflection factors of various polished metals suitable for use as reflectors.

TABLE 1—REFLECTION FACTORS OF VARIOUS METALS

Surface	Reflection Factor, Per Cent
Silver-plated	85 to 90
Aluminum	62 to 67
Nickel-plated	50 to 55

Red, bordering on orange, has been used almost universally for *Stop* signal lenses. For *Direction* and other signals, green and yellow as well as red have been used. Natural colored glass assures a permanent color. Dips, sprays, etc., sometimes have a tendency to flake or peel off under service conditions.

In order that the signal may have brightness and sparkle, the lens surface should be composed of many small prisms or individual lenses capable of breaking up the solid beam of light from the reflector into a multitude of overlapping individual beams traveling in the same general direction. These irregularities should preferably be on the inner side to facilitate keeping the outer surface clean. The four-sided prisms of commercial glassware bend the rays of light in four different directions, producing two bands of light that cross at an angle

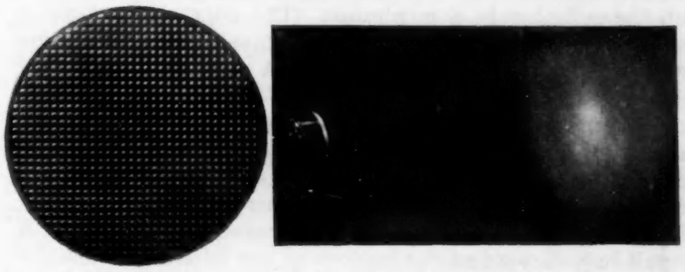

FIG. 6—LENS WITH A DESIGN CONSISTING OF SMALL BULLSEYES OR BUTTONS, EITHER RAISED OR INDENTED, AND THE CROSS-SECTION OF THE BEAM FROM THIS LENS WHEN THE PROPER LAMP AND REFLECTOR ARE USED

depending upon the angle of the prisms. There is a definite "dark spot" in the beam from prisms of this description. Should the driver approaching from the rear of the car with such a signal happen to be in the dark area, as at x, Figs. 4 and 5, the effectiveness of the signal is greatly reduced. The design of individual prisms or lenses is highly important. Each should throw a part of the light which strikes it to every part of the main beam from the entire lens. The photographs of Figs. 4 and 5 illustrate the limitations of four-sided prismatic designs and the better results obtainable through the use of small bullseyes or buttons are brought out in Fig. 6. The cross-section of the beam from this type of lens shows no dark areas. Consequently the driver in the rear receives a uniform flash at any point in the beam. This type of prism design is most effective. A spread of light of about 40 deg. from each small bullseye gives satisfactory results. Another possible method is to pebble the surface of the reflector itself; smooth cover glass may be employed and a result somewhat similar to that produced by the bullseye design obtained, although the efficiency is somewhat lower due to cross reflection.

FIG. 7—THREE TYPICAL FACE PATTERNS

At the Left Only the Letters Are Visible and the Remainder of the Lens Face Is Opaque; While the Total Bright Area Is Small and No Annoying Glare Is Produced at Night, a Tendency for the Letters To Blur Exists. In the Central View Only the Letters Are Opaque and the Remainder of the Lens Face Is Visible; the Large Exposed Area in This Case Is Likely To Cause Serious Glare at Night. In the Design at the Right Only the Letters and a Circular Border Are Visible and the Remainder of the Lens Face Is Opaque; This Is a Very Satisfactory Design Since the Addition of the Lighted Border Lessens the Tendency of the Letters To Blur, While the Total Exposed Area Is Kept Sufficiently Small To Avoid Objectionable Glare at Night

The visibility of a signal in daylight depends very largely upon its brightness, and to compel attention in the daytime it is necessary that the brightness be of a high order. This brightness may be prevented from producing a blinding effect at night by keeping the bright area small in size, for glare is a function of both brightness and the quantity of light. For this reason certain portions of the lens are opaqued. Three representative face designs are shown in Fig. 7. As explained in the captions, an illuminated border increases the legibility of illuminated characters on a dark background at night. This feature is of importance in the design of direction signals that depend upon legibility rather than color to indicate the direction of the turn.

The housing should be as nearly dust and waterproof as possible, to reduce tarnishing of the polished surface of the reflector to a minimum. The corrosive action of salt water renders reflectors used in sea-side atmosphere especially susceptible to tarnish. A very slight layer of dust greatly impairs the reflecting qualities of the mirrored surface and reduces the brightness of the signal accordingly. Rubber gaskets should not be used to render the housing moisture-proof since the sulphur content of the rubber soon discolors the mirrored reflector surface. Cork or felt gaskets have proved satisfactory. A small hole or vent at the bottom of the housing is usually provided, as in headlamp design, to prevent collection of moisture.

The indicator usually takes the form of a low-candlepower lamp, mounted on the dash, which lights or flashes when the signal operates. It should be designed and placed so that the driver will be conscious of its flashing even in bright sunlight. Its indication should be positive and definitely dependent upon proper operation of the signal. It should be connected in the circuit so that its operation does not materially reduce the brilliancy of the signal itself and, for reasons already stated, it should be designed for a standard lamp.

In some cases bare lamps have been used, but the glare at night is likely to be objectionable. Where colored, they would be classed as special lamps and are therefore open to the objections previously mentioned. Various designs of glass for indicator-lamp caps have appeared on the market. In some cases the glass has had its surface cut in facets resembling a jewel. A very satisfactory form of cover glass is obtained by using a colored glass with the inner surface designed as recommended for signal lenses. This design provides sufficient angular spread and brightness with a 2-cp. lamp to render the indicator clearly noticeable to the driver in bright sunlight, without causing objectionable glare at night.

The wiring of the indicator must be such that if the signal lamp burns-out, the wire breaks at some point or the switch fails to close or to separate, the indicator lamp will, through its improper operation, call attention to the trouble. Failure of the indicator lamp itself can be checked by operating the signal switch and watching the ammeter; a reading of about 3 amp. as the switch is operated, indicates that the signal lamp is operating properly and that the indicator lamp is burned out.

Four of the most common wiring-plans employed for the indicator system may, for purposes of discussion, be termed the series, the shunt, the series relay and the series flasher. The first method consists of placing the indicator lamp in series with the signal lamps and the former is lighted as long as the signal lamp is on. To obtain brightness at the signal, it is necessary virtually to remove part of the filament from the signal lamp and place it in the bulb of the indicator lamp. This is objectionable because it makes necessary the use of special lamps in both signal and indicator, for a standard 21-cp. lamp used in series with any type of indicator lamp will operate at a materially decreased brightness. The fact that special lamps are required for both signal and indicator means that when either lamp burns out, the user will have great difficulty in obtaining a renewal, since special lamps are not to be found in the stock of the ordinary lamp-dealer.

The shunt system consists of a resistance placed in the signal-lamp circuit around which is shunted a low-voltage indicator-lamp. The voltage-drop across the resistance is sufficient to light the indicator lamp which remains lighted as long as the signal lamp is on. This voltage-drop across the resistance, however, reduces the voltage available at the signal lamp, with the result that its candlepower is considerably reduced. Where standard lamps are employed with this system the candlepower loss at the signal is great even though the indicator lamp is but dimly lighted. This system therefore has very much the same disadvantages as the series method of connection, in that the brilliancy of the signal lamp is seriously reduced by the indicating device. This method has been tried out by several manufacturers of signal devices, and in almost all cases has been discarded.

The series-relay system employs a standard 2-cp. lamp on the dash with the standard 21-cp. lamp in the signal. The dash lamp is lighted by the action of a magnetic relay in the signal-lamp circuit which closes a contact, thus lighting the indicator lamp. The indicator lamp remains lighted as long as the signal lamp burns. When the signal is turned off, the magnet releases its hold, the contact opens, and the indicator lamp goes out. One of the cardinal points to be remembered in connection with the design of a safety device is the necessity of keeping the number of parts in which there is a chance of failure, even though remote, to a minimum; with the series-relay system there is always the possibility of sticking contacts. A reasonably reliable relay is also necessarily expensive. To render the signal effective it is necessary that the resistance of the winding be kept extremely low.

The series flasher appears to be the simplest and most effective method of indicator-lamp control yet devised. A standard 2-cp. lamp is used for the indicator and a standard 21-cp. lamp for the signal. As the switch is operated, the movable member *a* passing to the position *b* momentarily places the two lamps in series. The 2-cp. lamp, having the higher resistance, is lighted to practically its full brilliancy, although the current at this time is insufficient to light the larger signal lamp. As the switch action is completed by the movable member passing to position *c*, the indicator lamp is short-circuited and goes out and full voltage is impressed on the signal lamp, which then lights at full brilliancy. This process is repeated in the reverse order as the switch arm *a* moves back to its original position. A flash of the indicator lamp is thus obtained each time the signal is turned on and off.

With a slight change this indicator system can be readily applied with equal effectiveness to a multiple signal system comprising *Direction* as well as *Stop* signals. Fig. 9 shows the connections for such a system.

Switches should follow certain recognized fundamentals of design regardless of whether they are operated automatically or manually. Many of the difficulties that were experienced with the early forms of electrically lighted signals were due directly to faulty switch design.

Elements of switch design that result in low electrical resistance and more satisfactory operation in general are

(1) Wiping contacts rather than butt contacts
(2) Air insulation between fingers
(3) Reasonably stiff spring fingers of generous size
(4) Short action

The usual instruction booklet accompanying signal equipments recommends that the switch be placed underneath the car; in initial equipment installations, it is commonly mounted on the chassis. Since the switch is likely to be exposed to exhaust fumes, mud, etc., it is essential that an adequate housing be provided.

For satisfactory lamp performance sockets should be well designed both mechanically and electrically. Poor contacts frequently cause a high resistance-drop and a consequent loss in candlepower at the lamp. Furthermore, the heat developed at the points of poor contact may soften an inferior composition to such an extent that it is forced out of the shell by the spring pressure, rendering the socket unserviceable; even summer temperatures are sufficient to produce this softening in the poorer grades of material. Undersized springs and springs which may carry a considerable part of the current are frequent sources of trouble.

Important electrical and mechanical features are

(1) Moisture-proof insulating material which will not soften under moderate heat, fastened securely to the shells
(2) A current path of low and unvarying resistance
(3) Soldered electrical connections, where practicable, free from any bending action or strain at the joint
(4) Sufficient stock, where binding screws are used, to prevent stripping of the threads
(5) Rustproof springs, providing from 50 to 150-oz. pressure on the lamp-base contacts, preferably arranged so that they cannot carry current
(6) Protection from chafing where insulated wire touches the socket shell

Armored cable is accepted as the standard of good practice in automobile wiring, and it is especially desirable in the case of signal systems, where safety and continuity of operation are essentials. The oiled linen insulation of armored cable is practically impervious to gasoline, oil or water, while the metal armor protects the insulation from abrasion. This is especially advantageous in installations made by the car-owner, where the wire is likely to be led through any convenient hole and may be subject to considerable wearing action. The wire should be No. 14 B. & S. gage to insure against loss of candlepower at the signal lamp from excessive resistance in the wire itself.

The signal circuit should never be connected directly to the car battery without fusing. If no fuse is supplied with the signal equipment, care should be taken to

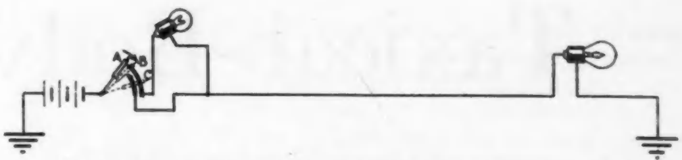

FIG. 8—THE SERIES-FLASHER CONNECTION OF THE SIGNAL AND INDICATOR LIGHT

connect it to some part of the electrical system of the car that is properly fused. A practice, electrically equivalent to link fuses fastened firmly under binding-posts, is recommended rather than the use of cartridge fuses and clips employing butt contacts. Due to the lack of cleaning action, small area of contact, corrosion, electrochemical action, etc., the cartridge fuse is very often the source of considerable voltage-drop. If cartridge fuses are used, both the fuse ferrules and the clips should be nickel-plated to prevent electrolytic action.

IMPORTANCE OF A MINIMUM ELECTRICAL RESISTANCE

In the discussion of the electrical design of the various component parts of the signal system, emphasis has been laid upon the importance of keeping the electrical resistance of the circuit at a minimum. The reason for this becomes apparent when one considers that voltage-drop in a circuit is equal to the resistance multiplied by the current and that motor-vehicle lamps are necessarily high-current lamps. The standard 21-cp. 6 to 8 volt lamp, for example, while drawing only 20 watts from the battery, nevertheless uses more *current* than a 115-volt lamp of the 300-watt size and for a proportional candlepower loss would require an even larger size of wire.

The voltage-drop in the circuit, which means less voltage at the lamp filament, has a far more serious effect upon the candlepower of the lamp than is generally realized; a slight reduction in the voltage produces a material reduction in candlepower. For example, a 10-per cent loss in the voltage at the filament results in a 30-per cent loss in the candlepower of the lamp.

Voltage losses due to unnecessarily high resistance may occur in the switches, sockets, fuses or the wiring itself. Attention to the details of electrical design as discussed above will materially reduce these losses and make for greater effectiveness of the system as a whole.

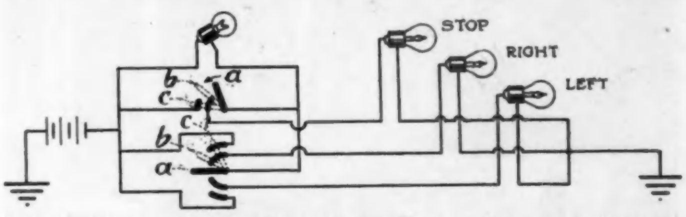

FIG. 9—AN ADAPTATION OF THE SERIES-FLASHER SYSTEM TO SIGNALS USING SEVERAL LAMPS

RECLAMATION OF USED PETROLEUM LUBRICATING OILS

A LARGE amount of lubricating oil is now wasted because it is thrown away as unfit for further use. Yet such oils can be reclaimed and made as good as new, or even better, by simple apparatus already commercially available. For example, the oil in the crankcases of automobiles becomes contaminated with dust and dirt and diluted with the gasoline that leaks into it, and when the owner reads his book of instructions or is otherwise reminded of crankcase dilution, he drains out the oil and throws it away. This is a needless waste and in certain cities arrangements have already been made to collect and reclaim crankcase oil.

In an investigation that the Bureau of Standards has conducted with apparatus for reclaiming oil, it was found that, judging by all the commonly accepted standards, the reclaimed oil is as good as new. Certain changes in the oil could be detected by special tests, but it is a matter for future investigation to decide whether or not these changes are detrimental or whether these special tests are necessary.

Taxicab-Body Construction

By HUGH G. BERSIE[1]

CLEVELAND AUTOMOTIVE TRANSPORTATION MEETING PAPER *Illustrated with* DIAGRAMS AND PHOTOGRAPHS

THE author states briefly the phenomenal growth of taxicab usage and consequent demand for this type of motor vehicle, mentions the differences in body requirements for taxicabs as compared with those of passenger cars and describes the methods used to secure durability in taxicab-body construction to discount the severe service to which the body is subjected.

Tabular data are presented and comment made regarding the woods that are suitable for body framework, and the methods of joining frame members, and reinforcing frame joints are outlined. The desirable types of roof and the factors that influence design are discussed at some length, illustrations being presented also, and minor considerations such as types of hardware, dash and instrument-boards, are included. A brief summary states present conditions, and a bibliographical list is appended of informative publications relating to the subject.

ON Jan. 1, 1922, there were 75,000 taxicabs operating in the United States, an increase of 46 per cent as compared with Jan. 1, 1921. It is estimated that on Jan. 1, 1923, at least 110,000 cabs were in service. These figures serve to indicate the rapid progress being made in the field.

The efforts of many passenger-car builders have been directed along the line of producing an inexpensive lightweight closed-car. The taxicab, on the other hand, must be durable and so well built as to run approximately 50,000 miles per year as compared with the passenger-car's average of about 7000 miles. Taxicab service demands not only the maximum durability in the body, the engine

FIG. 1—TAXICAB BODY SHOWING HEAVY SILLS, DOOR PILLARS AND DOOR FRAMES

and the chassis, but also provision for the satisfactory and easy replacement of any worn or damaged parts, a factor often overlooked. The plan of this paper is to

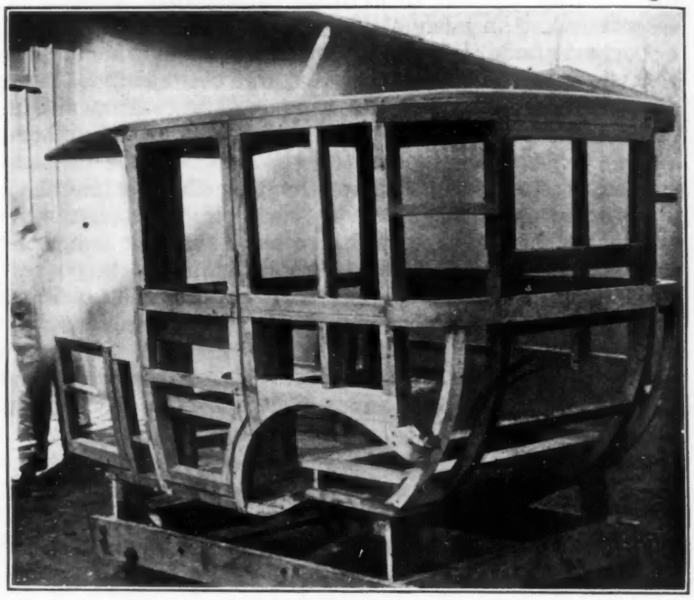

FIG. 2—A SUBSTANTIAL, WELL-BUILT CAB IN WHICH BOTH ASH AND OAK ARE USED FOR FRAME MEMBERS

suggest a means of attaining these ends in body construction.

METHODS OF SECURING DURABILITY

The prospective purchaser of a taxicab is interested in the durability of the body as well as that of the engine and the chassis. The taxicab's appearance is a business asset to him. Very likely, it influences the amount of his business more than is commonly supposed. Accordingly, taxicab-body design and workmanship are of such importance as to warrant their serious analysis and improvement. We shall begin with the body framework, because the quality of the whole job is reflected in this one item more than in any one other.

First, heavy sills are very desirable. They are about 50 per cent heavier than in passenger-car bodies of the same size. In Fig. 1, the heavy type of sill is noticeable. The numerous "gunstocks," as well as the panelled roof, reinforce the frame members. That part of the sill which is over the wheelhousing can be reinforced by an iron strap applied to the side of the sill. Bent or formed sills are rarely if ever used; it is customary to build-up the sills by screwing and gluing several pieces together to secure the required shape. Tests indicate that the four-piece construction is most desirable.

The door pillars and door frames are next in importance. Since the doors themselves must be exceptionally heavy so as to prevent warping, it follows also that their pillars must be correspondingly heavy. The rear pillars may be about 2 in. thick and should at no point have deep mortises or cut-outs that would weaken them at these places. Such cut-outs weaken the pillars more than a computation of the section moduli would indicate, for

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the stresses tend to concentrate at these points. Rear doors, as light as those in passenger cars, will soon warp so that they will not close at the upper front-corners. Front doors have the lock near the upper corner, and hence the lower corner tends to spring away so that it does not close flush. This can be remedied by screwing a diagonal steel strap to the door framework on the inside. This strap pulls the corner in; it subsequently can be covered by the door lining. Fig. 2 illustrates the heavy construction of doors and pillars desirable in taxicab bodies. This body, like the body shown in Fig. 1, carries a full-panelled roof.

Woods Suitable for Body Framework

Mountain or white ash, Fraxinus Americana, is the best wood for frame members. The substitution of yellow poplar has been made to some extent, but its strength and screw-holding properties do not equal that of ash. The value of poplar lies in its use for miscellaneous parts, such as arm rests, that subsequently are upholstered. Upholsterers like to work on poplar, because nails are easily driven into it.

It is often valuable to have information on the strength properties of the various woods that are suitable and available for body construction. Table No. 1 lists the strength values of these woods. Complete information on this subject is available in Government reports on the Mechanical Properties of Woods Grown in the United States.[2]

TABLE 1[a] — STRENGTH PROPERTIES OF WOODS USED IN AUTOMOBILE-BODY BUILDING

Species of Wood	Where Grown	Weight, Air Dried, Lb. per Cu. Ft.	Strength as a Beam or Post	Shock Resisting Ability	Stiffness
White Ash, Forest Grown	Arkansas West Virginia	40	100	100	100
White Ash, Second Growth	New York	44	122	120	118
Sugar Maple	Indiana Pennsylvania Wisconsin	43	104	90	106
White Oak	Arkansas Indiana Louisiana	48	97	96	99
Yellow Poplar	Tennessee	27	67	41	94

[a] Information given in Forest Products Laboratory Report on Project 6516, M-1.

"Case-hardening" of lumber in the kiln-drying will cause the wood to warp when shaped into the frame members. This condition, its cause and the remedy are fully described by the reports of the Forest Products Laboratory.[3] Light-weight ash is often brash and should not be used. A minimum specific gravity of 0.56, based on oven dry-weight and volume, is suggested by the Forest Products Laboratory. Sometimes, ash of good weight is brash, due to the presence of decay. Stains frequently indicate this decay, and lumber containing stains should be regarded with suspicion.

Results of laboratory tests indicate that the different woods vary considerably in their screw-holding properties. The woods in this respect rank as follows: (*a*), sugar maple; (*b*), white ash; (*c*), white oak; and (*d*), yellow poplar. Poplar is very inferior in this respect but, as stated above, it is valuable for trimming strips to which upholstering is subsequently applied.

Methods of Joining Frame Members

The best practice is that of gluing and screwing all joints of the frame members. Long screws are employed and carefully driven immediately after the application of glue to the joint. Animal glue is frequently used because of its convenience. In using this glue, it should be remembered that long-continued heating reduces its strength.[4] Waterproof glues are valuable when care is taken in their proper mixing.

The quality of a job is judged to a great extent by the joints. To secure tight frame-joints, careful workmanship is required. Modern woodworking machines have been highly developed so as to make the forming of the joints almost automatic, but these do not eliminate the need of careful, conscientious workmen for the actual assembly, men who will reject members that have been formed improperly. The racking twisting stresses to which a body is subjected necessitate the best joints; otherwise, body squeaks soon develop, the doors fail to open and close properly, and the body is condemned to the junk heap too soon. Regarding the need of reinforcing frame joints, an inspection of Figs. 1 and 2 shows the large number of "gunstocks," or corner reinforcements, which act structurally as gusset plates, taking some of the strain ordinarily carried by the joints themselves. This sort of construction is neglected in passenger-car bodies, but it is very essential in cabs.

Types of Hardware and Molding

Door hinges and locks have been an object of much study. The rear-door hinges are almost universally of the standard curved-joint pattern of malleable iron. From the standpoint of both durability and easy replacement, they are far better than the concealed type. They have the additional merit of carrying the door back as it swings, and thus increasing the width of the door opening. For safety's sake, rear-door catches are of the two-step variety.

Aluminum molding is used somewhat largely, not only on the body but also for the drip-rail on the roof. This molding can be fastened into place by screws or cement-coated nails. In the latter instance, a good method is that of spinning a conical circular hole in the molding by the use of a revolving center punch. This process forces the metal up, so that the metal subsequently can be hammered down in place after the brad is driven. The method described is one lending itself to fast production, and also one assuring that the finish on the molding will be relatively permanent.

Types of Roof

Taxicab roofs are designed and constructed far differently than for passenger cars. The panel roof is in universal favor with taxicab builders and, when properly constructed and installed, gives excellent service in all closed cars. The trouble that was formerly experienced with drumming or vibration has been practically eliminated by proper methods of installation. At present, all large-quantity cab-builders use plywood molded-roofs.

One method well known to the trade for dampening out roof vibrations consists of fitting felt or padding between

[2] See United States Department of Agriculture Bulletin No. 556.
[3] See Forest Products Laboratory Technical Note No. 112.
[4] See Forest Products Laboratory Technical Note No. 104.

FIG. 3—PLYWOOD CAB ROOF CARRYING SEVEN MEN

the roof-panel and the ribs. However, this has been found only partially effective. Very frequently the drumming experienced in closed cars is not due to the roof, but rather to the glass; such drumming can be detected by placing one's hands on the window glass. In the Yellow Cab body the practice of insulating both the glass from the frame and the frame from the body is followed. Vibration of the roof itself may be eliminated by a certain type of construction that has so far proved wholly effective; it consists in the installation of the roof in two pieces, the joint being over the partition between the driver and the passenger compartments. We suspected

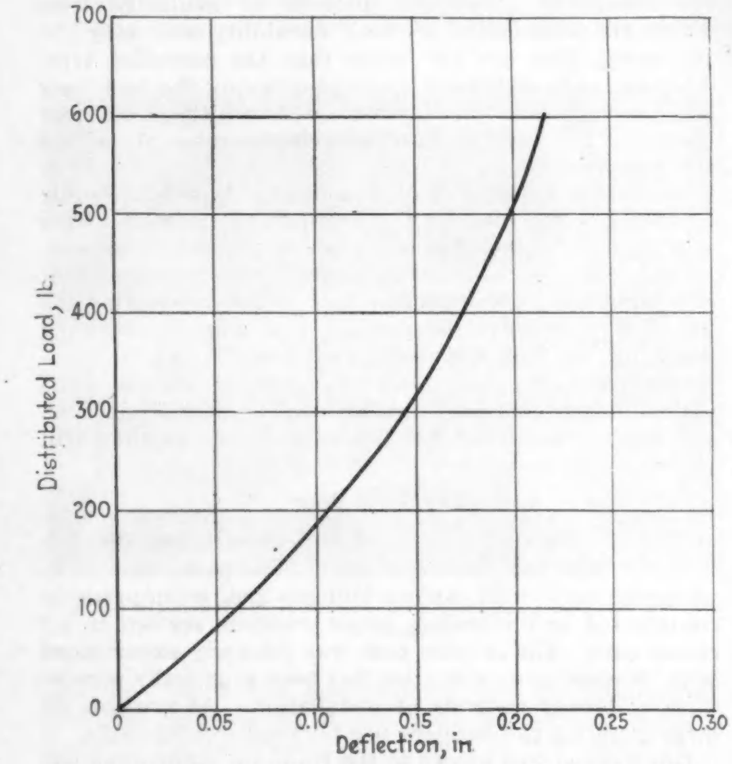

FIG. 4—LOAD-DEFLECTION CURVE OF A UNIFORMLY LOADED PLYWOOD ROOF

that this would eliminate the trouble, several years ago. Recently, complete confirmation has been made by a large-quantity body-builder who tried this method. The theory back of this plan is the isolation of the two portions of the roof, so that any slight vibration is damped-out rather than reinforced. It was feared that the joint would weaken the roof, but service tests have indicated that, if anything, it is stronger. At any rate, these roofs have plenty of longitudinal stiffness to spare. Bending tests made on our 5/16-in. roofs, 59 x 97 in., glued to a frame of ash showed that the panel strengthened this roof by more than 85 per cent. Moreover, the frames used were exceedingly heavy; 2 in. deep and 2¾ in. wide, and had no ribs.

However, operators consider the transverse strength of the plywood roof to be of the greater value. In 90 per cent of the accidents to Yellow Cabs, the blow is delivered to the rear quarter panels below the belt line, right

FIG. 5—HYDRAULIC, STEAM HEATED DIES USED FOR THE FORMING OR MOLDING OF TAXICAB ROOFS

or left side, with the result that in very few cases the destruction extends beyond the rear door pillars, it is most remote when it extends beyond the partition. The Yellow Cab Mfg. Co. says that this is due to the strength of the particular type of roof panel employed as well as to its methods of applying such roofs.

The need of the greater strength afforded by a plywood roof is apparent when the strengths of the average roof-rails and roof-ribs are determined. For instance, a roof-rail of ash of average section 3 in. deep and 1⅞ in wide, will deflect 1 in. under a horizontal side-load of 165 lb. applied at the center of a 90-in. length. Suppose that the load is distributed, say 10 lb. per rib for eight ribs in a 90-in. length, then the frame would be spread ⅝ in. at the middle portion. This shows how deficient the roof-rail and roof-ribs are with respect to lateral or transverse strength, and slats or wire-mesh do not increase its strength very much. The adoption of a canopy plywood roof gives the roof a strength that permits the use of a slat construction and a safety opening to the rear of the center partitions. The enormous strength of the plywood roof is shown in Fig. 3, where a 5/16-in. roof is carrying the weight of seven men, their estimated weight being 1000 lb.

A quantitative test made along similar lines gives the load-deflection curve shown in Fig. 4. In this test, one of our 5/16-in. roofs glued to an ash frame, having a roof-rail 2 in. deep and 2¾-in. wide, with no supporting ribs, carried a uniformly distributed load of 600 lb., with a central deflection of only 0.237 in. A maximum total load of 950 lb. was carried.

Construction of Plywood Roof

The panels are furnished by the manufacturers, molded to the required shape. Fig. 5 illustrates the dies employed for the forming of taxicab roofs. It should be understood that, in this particular process, the panels are first glued-up flat in hydraulic steam-heated presses. Subsequently they are placed in steaming tanks or vats. While wet and somewhat softened, the panels are pressed out to shape in the steam-heated dies. Much research has been directed toward the improvement of this process until, at present, the results are very satisfactory.

Practically all of the roofs are of the three-ply construction, ¼ or 5/16 in. thick. Upon receiving these panels from the manufacturer, the body-builder bandsaws them to shape from a template and then clamps and glues the panel to the roof-rail or the frame at all edges. Fig. 6 illustrates this construction, wherein the roof-rail has been rounded or formed on a shaping machine after the glue has set. Ribs are not employed in that portion of the roof over the driver; at that section, this roof gives a smooth panelled appearance without the need of upholstering or interior covering.

Some builders do not consider it necessary or even desirable to attach the passenger portion of the roof to the roof-ribs. In case the panel is nailed or screwed, a padding of loose felt is placed between the panel and the bows or ribs.

After the shaping process already mentioned, the entire roof is covered either with glazed duck or with plain sheeting. The glazed duck is already finished, and need not be glued to the roof. However, the sheeting is easily glued to the roof-panel and is inexpensive, except that it requires a fairly good paint finish. A roof so constructed is light and durable, and affords a reliable watershed. In case the cloth covering is torn or ruptured, and this is unlikely because the roof-panel itself takes all the stresses, the panel itself will shed water; this saves the upholstering and the interior furnishings of the car until such time as the roof covering can be repaired. This construction absolutely prevents the buckling or wrinkling of the roof covering.

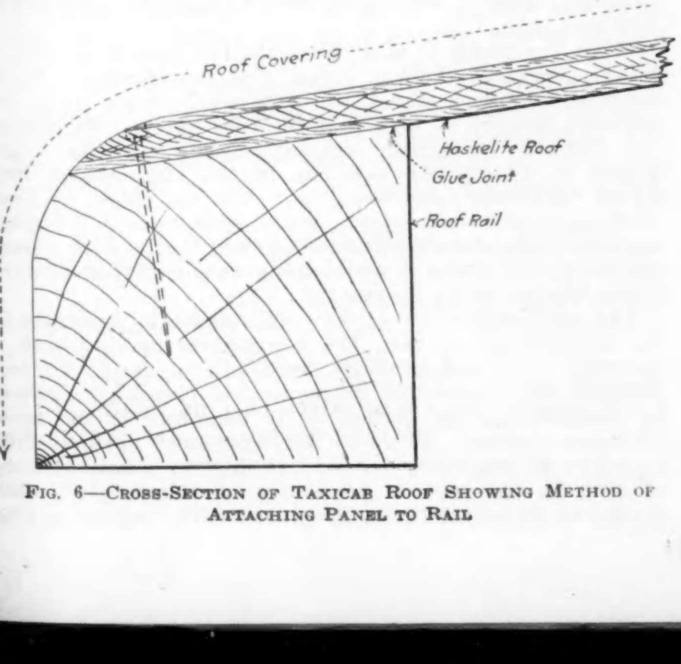

Fig. 6—Cross-Section of Taxicab Roof Showing Method of Attaching Panel to Rail

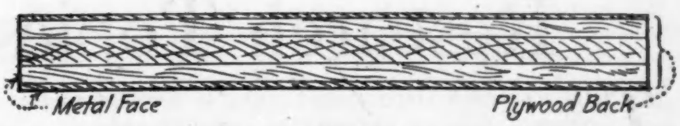

Fig. 7—Cross-Section of a New Type of Instrument Board, Showing the Plymetal Construction Recently Adopted by Several Large Body-Builders

This last point brings us to a consideration of the grade of plywood that is satisfactory for roof-panels. The plywood bonded by animal glue is not suitable. Expensive experience has shown that much. The waterproof plywood is recognized as the standard for roofs.

Types of Dash and Instrument-Board

In like manner, the waterproof panel of highest grade has found wide favor for dashes. It fills most of the needs of the dash, and a dash has many functions. It should act as a heat barrier, should deaden sound or vibration and act as a structural part of the body. The steel dash fails on several counts; it tends to rust, the bolt fastenings work loose and it is difficult to remove and replace if spot-welded in place. This point of replacement must be considered at all times in taxicab-body construction, as contrasted with passenger-car design.

A new type of instrument-board is shown in Fig. 7. This board of plywood and metal is easily fabricated, and combines all of the advantages of the pressed-steel wood-backed combination. The metal face, glued to the plywood back, can be bent over one end of the board.

Costs and Records

The cost of a taxicab body is about 40 per cent of the total cost of the cab. It is not amiss, therefore, to lay due stress on proper body-design and construction. In fact, it is of more importance than the cost proportion.

The keeping of accurate and comparable records by taxicab operators is proving of great value in the improvement of taxicab construction. Every failure of parts is a lesson, and points the way to improvement. Here is firm ground for the progressive engineer.

Present conditions can be summarized as follows:

(1) The severe service rendered by the taxicab requires the most durable type of body construction
(2) Proper joining of the frame members is of the utmost importance in producing a serviceable body
(3) The plywood molded-roof of the waterproof type is of accepted merit for taxicabs
(4) The body should be of such construction as to allow the easy replacement of parts

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Lumber Used in Motor-Vehicle Manufacture. Arthur Koehler. *Automotive Industries*, May 26, 1921, p. 1114.

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Plywood and Its Uses in Automobile Construction. Armin Elmendorf. The Journal, May, 1920, p. 299

Strength of Screw Fastenings in Plywood. Forest Products Laboratory. Technical Note No. 149

Summary of Nail-Pulling Tests. Forest Products Laboratory, Aug. 5, 1919.

Utilization of Ash. Department of Agriculture Bulletin No. 523

Research Topics and Suggestions

THE Research Department plans to present under this heading each month a topic that is pertinent to the general field of automotive research, and is either of special interest to some group of the Society membership or related to some particularly urgent problem of the industry. Since the object of the department is to act as a clearing-house for research information, we shall be pleased to receive the comments of members regarding the topics so presented, and their suggestions as to what might be of interest in this connection.

WAVE TRANSMISSION OF POWER

ARTICLES have appeared recently in a number of foreign journals[1] describing a comparatively new development in power transmission that may be of interest as offering another possible solution of certain automotive transmission problems. Although the more obvious applications appear to be in such operations as rock drilling, riveting, punching, etc., it is claimed that the method has been successfully applied to the transmission of power from an engine to the propeller both in marine and in aeronautical installations. If these claims are substantiated, the method may have a much wider application than appears at first sight.

The methods of transmitting power that are in commercial use at the present time may be divided into five classes, as follows: steam, direct mechanical, electrical, compressed air and hydraulic. What is claimed to be a sixth method employs wave motions or pulsations set up in an enclosed column of liquid, the power being transmitted as a result of waves of the compressed fluid traveling at the speed of sound. The principles underlying this wave transmission of power are said to be wholly different from those governing hydraulic transmission, for in hydraulics, as commonly understood, a continuous flow of liquid is used, while in wave transmission there is no direct flow.

The first instance of power transmission by a pulsating column of liquid is found in the synchronizing interrupter gear for airplane machine guns, invented by George Constantinesco. The same inventor has also developed a new rock-drill actuated by impulses transmitted through a flexible pipe-line filled with water. This new rock-drill has been

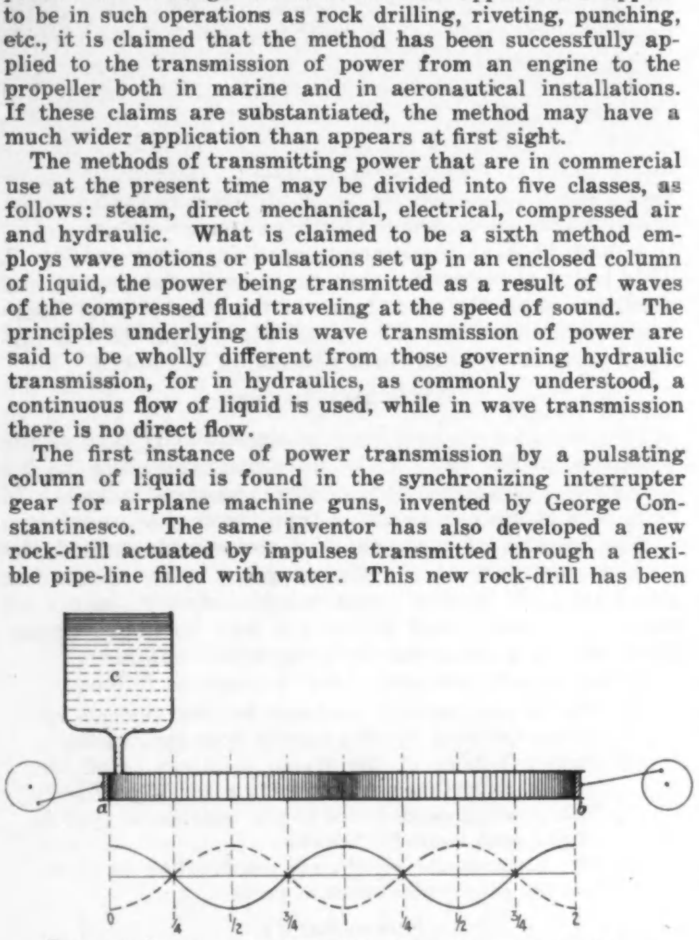


DIAGRAM ILLUSTRATING THE WAVE TRANSMISSION OF POWER

reported to be operating satisfactorily and to be doing its work faster and cheaper than is possible with the standard compressed air drills. In view of this accomplishment, an outline of the method of operation of this novel system of transmission may be of interest, especially as its promoters have announced that another development is under way for utilizing the characteristics of wave motion in the field of automotive engineering.

If a water-tight piston is pushed slowly into a pipe completely filled with water, the column of water may be regarded as a connecting rod that imparts the slow motion of the piston at *a* to the piston rod *b* at the other end of the pipe. During this transmission of the pressure from *a* to *b*, the column of water is slightly compressed, but the pressure throughout the column of water is everywhere uniform and all parts of the water column have everywhere the same direction and velocity of motion. If the piston *a* is now given a fast reciprocating motion, the inertia of the long column of water will interfere with the simple connecting-rod action just described and instead there will be local compression and rarefaction of the layer next to the piston *a;* this layer of compression will move through the column of water according to the laws for the propagation of elastic disturbances in liquids. In contradistinction to the simple hydraulic case, the distribution of pressure is no longer uniform throughout the length of the column of water, but varies as shown by the shading in Fig. 1.

The compression waves thus formed are progressive, that is, the compressed layers, spaced one wave-length apart, are propagated along the column of water at a velocity given by the formula:

$$v = ge/D$$

where

D = the density of the liquid or its weight per cubic foot.

e = the modulus of compressional elasticity in pounds per square foot.

g = 32.2

Calculating e from the compressibility of water, which is 0.000047 per atmosphere, gives 4800 ft. per sec. for the velocity of the compressional waves in water.

There is a complication in case the motor does not absorb all the power delivered by the generator. To see what happens under these conditions, let us take the extreme case where the piston *b* is held stationary, or where the end of the tube is closed. Then the compressional waves on reaching *b* are reflected and the reflected waves combine with the original waves to form standing waves. The sinuous curves in Fig. 1 show the pressure variations at any cross-section of the column of water after a standing wave has been established. The characteristic thing about a standing wave is that the layer of liquid in each cross-section of the column goes through a cycle of pressures and a cycle of motions depending upon its relative position in the wave. Thus, at the ends and at the middle of each wave-length there is the greatest range of pressure change, coupled with the minimum velocity range; at one-fourth and three-fourths wave-length the pressure change is zero, but the velocity change in each period is a maximum.

When less power is taken from the line than is fed into it by the generator, there is danger that the amplitude of the resulting standing waves will steadily increase until the pressure becomes so high that the tube bursts. To obviate this difficulty, large reservoirs, indicated by *c* in Fig. 1, are placed at appropriate positions in the transmission line. These "hydraulic condensers," as they are called by Constantinesco, act similarly to electric condensers in an alternating-current electric-transmission line; that is, they absorb the energy not needed in maintaining wave motion and return excess energy to the generator.

The two installations of wave rock-drills, as described in the engineering journals, are designed to operate with a standing wave, and although the details of design are not divulged, it is implied that the mechanical advantage is gained by dimensioning the various parts according to the wave constants involved. Thus, the wave-generator speed is 2400 r.p.m., or 40 revolutions per sec., which, with a wave velocity of 4800 ft. per sec., as previously calculated, gives 4800 divided by 40, or 120 ft. for the wave-length. Agreeing with

[1] See *The Engineer* (London), Oct. 27, 1922, p. 444; and Nov. 3, 1922, p. 446; see also A Treatise on Transmission of Power by Vibration, by George Constantinesco, published by Walter Haddon & Co., London.

this calculation, the length of the transmission line is 60 ft., or half a wave-length. Reference to the sinuous curve of Fig. 1 shows that with this length of pipe the hammer of the drill is located at a point where the pressure variations in the standing wave are greatest, and it is stated that the drill will operate only so long as this relation between the wave-length and the position of the hammer is held to within 5 per cent.

Another feature of the rock-drill that depends upon the characteristics of wave-motion is the dependence on resonance, that is, on tuning as it is practised in radio. In developing his theory Constantinesco derives formulas that are practically identical with those holding for the relations in alternating-current electric circuits; thus, there are terms containing C, the capacity of hydraulic condensers, depending upon elastic properties either of spiral springs or of hydraulic compressibility. There are also terms in L, corresponding to the coefficient of induction, which, for liquid waves is represented by inertia, that is, by mass or weight.

In any case of wave motion, there is resonance between two circuits when the periods $n = 1/[2\pi\sqrt{(LC)}]$ are multiples; tuning consists in varying C or L or both, until the resonance is attained. In the rock-drill the inertia, L, of the hammer, and the hydraulic capacity C of the chamber in which the hammer moves, are adjusted according to the formula just given until there is resonance with the transmission line, and furthermore, the conditions for maximum impact, as determined theoretically, are said to be embodied in the design of the rock-drill and to be responsible, in a great measure, for its favorable performance. There are no published experimental data from which to judge the degree to which the theoretical deductions are realized in practice, but if we take in good faith the claims of the inventor and of the manufacturers, we should expect that this new system of power transmission could be applied with advantage to operations involving percussion, as, for example, in riveting machines and piledrivers. As an example of this type of application to internal-combustion engineering, the manufacturers cite a valve-actuating device that has been used successfully on a large marine Diesel engine for operating the fuel, inlet and exhaust-valves.

While the standing-wave type of liquid transmission thus seems peculiarly adapted to the operation of a percussion machine, it is easy to see that the very close regulation required for resonance makes this method impracticable for driving a number of motors at variable loads from one generator. In this case, Constantinesco proposes rotary motors that are capable of utilizing the energy of what we have called progressive waves. The theory of power transmission by progressive waves is strikingly similar to the theory of power transmission by alternating electrical currents, and involves, besides the constants R and C already mentioned, the hydraulic analogues of resistance, leak, step-up and step-down transformers, power factor and other terms familiar to the electrical engineer. For the rotary motor, also, this parallelism between wave-transmission and alternating-current electrical machines is very close. The motor may be a single-phase synchronous machine, which, like its electrical analogue, can be started only after it has been brought into step with the generator, and it can be operated on only a narrow range of speeds and loads. A synchronous alternating-current electrical motors were made possible by the use of three-phase systems and the polyphase idea was then adapted to single-phase systems by the use of a phase-splitting device for starting. Similarly, wave-motors are to be constructed for operation with progressive waves transmitted through a single line of pipe or through a system of three pipes, corresponding to single and three-phase alternating-current motors, and, furthermore, these motors may be built as synchronous or as asynchronous machines.

The manufacturer of the wave transmission equipment states that it has constructed for the British Government two power-transmitting units of the three-phase type; one for driving the propeller of a warship, and the other for driving the two propellers of a twin-screw airplane from one engine. It also intimates that a trial of this rotary motor in a railcar is contemplated. These and other projected applications of the progressive-wave type of wave-transmission have evidently not reached the stage where results can be made public, and it would be futile to speculate concerning either the correctness of the underlying theory, or the practical significance of the proposed method of transmission.

MIDGLEY RECEIVES THE NICHOLS MEDAL

THE Nichols medal is awarded annually for the best original paper published during the preceding year in one of the three journals of the American Chemical Society. This year the honor was awarded unanimously to to Mr. Midgley's article on the Chemical Control of Gaseous Detonation With Particular Reference to the Internal-Combustion Engine.

Mr. Midgley's address of acceptance, entitled Some Fundamental Relations Among the Elements and Compounds as Regards the Suppression of Gaseous Detonation, dealt with the chemical aspects of "anti-knock," that he defined as "a property of matter whereby a material acts as either a negative or a positive catalyst in the prevention of detonation in the internal-combustion engine." Mr. Midgley exhibited numerical data and graphical summaries for the anti-knock properties of 22 of the chemical elements. For instance, Table 1 illustrates how the anti-knock value changes for the most important of these elements.

TABLE 1—COMPARISON OF RELATIVE EFFECTS EXERTED UPON DETONATION BY ETHYL AND PHENYL COMPOUNDS OF FOUR ELEMENTS

Element	Reciprocal of Number of Grams To Give Anti-Knock Effect Ethyl Compound	Molecules Required Equivalent to One Gram-Molecule of Aniline[a] Phenyl Compound
Iodine	1.090	0.88
Selenium	6.900	5.20
Tellurium	26.800	22.00
Oxygen	— 0.036[b]	....

[a] Based on concentration of aniline up to 3 per cent by volume in kerosene.
[b] Induces detonation.

Among the data presented in Mr. Midgley's address are the following values for the reaction velocity constant K determined for the kerosene and the apparatus used by Mr. Midgley and Robert Janeway in the experiments described in the April number of the JOURNAL:

Concentration Pb Et_4 Cc. per Gal.	K
0	3.250×10^{-7}
1	3.170×10^{-7}
2	3.075×10^{-7}
4	2.970×10^{-7}
8	2.860×10^{-7}
16	2.760×10^{-7}

The decrease of K with an increasing lead tetraethyl concentration is in a sense predicted by Mr. Midgley's theory, but it should be noted that, although these figures probably give a correct idea of the variation, they include an apparatus variable and therefore do not represent the absolute values of the reaction velocity constant.

The far-reaching chemical significance of Mr. Midgley's researches on detonation is clearly expressed in this award to an automotive engineer of a prize much coveted by American chemists. This incident illustrates, furthermore, how research in one field often leads to results of the greatest importance in some apparently unrelated field, and the automotive industry, in congratulating Mr. Midgley on the signal honor bestowed on him, may well feel proud of its contribution to chemical science.

TENTATIVE STANDARDIZATION WORK

Criticism of all tentative reports should be sent to the Standards Committee in care of the Society

SIX-POINT CARBON RANGE PROPOSED

Iron and Steel Division to Consider Specifying Closer Limits for Steels

The Iron and Steel Division has been asked by a metallurgist connected with one of the larger automobile producers to consider revising the present S. A. E. Iron and Steel Specifications so as to specify, among other requirements, a six-point carbon range for alloy steels.

For many years the steel producers have been controlling their product so that the carbon-content has come within the range of 10 points (0.10 per cent) specified in the present S. A. E. Iron and Steel Specifications. Closer ranges have not been attempted, as it was recognized by the users as well as by the producers that such refinements would mean an increase in the cost of the steel. A few of the larger companies have, however, decided as a result of experience that for certain parts closer limits than those specified in the present S. A. E. Steel Standards are desirable. As they are purchasing in large quantities, it is possible for them to obtain closer limits through the use of resident inspectors at the mill. As it is impractical to use two methods of numbering steel in one plant, companies desiring steel made to closer limits have used their own specification numbers rather than the S. A. E. Specification numbers. It has therefore been suggested that the present method of numbering S. A. E. Steels be changed to a system that would make it possible to specify any steel composition. The suggestions that have been submitted to the Iron and Steel Division for consideration are given herewith.

(1) The carbon range of 10 points for all carbon steels to remain as at present
(2) The manganese range for all carbon steels to be 30 points
(3) The same sulphur and phosphorus limits to be specified for all carbon steels
(4) The same silicon limits to be specified for all carbon steels
(5) The carbon range for all alloy-steels to be 6 points
(6) The manganese range for all alloy-steels to be 20 points
(7) The same nickel range to be specified for all nickel, nickel-chromium or nickel-molybdenum steels
(8) The same chromium range to be specified for all chromium vanadium, nickel-chromium or chromium-molybdenum steels
(9) The same sulphur and phosphorus content to be specified for all alloy-steels
(10) The same molybdenum and vanadium ranges to be specified for all alloy-steels
(11) The adoption of a more comprehensive system of numbering

In reference to the adoption of a more comprehensive system of numbering the following system was suggested:

> The first two digits of the specification number should designate the classification of the steel as at present. The next two digits should designate the carbon-content desired, and the last two digits the manganese-content desired. S. A. E. Steel No. 103865 would then indicate a carbon steel of 0.38 per cent carbon, 10 points variation (0.33-0.43) and 0.65 per cent manganese, 30 points variation (0.50-0.80). The sulphur and phosphorus content would be standard as well as the silicon. S. A. E. Steel No. 333070 would indicate a nickel-chromium steel of standard nickel and chromium content, with carbon 0.30 per cent, 6 points variation (0.27-0.33) and manganese 0.70 per cent, 20 points variation (0.60-0.80). The sulphur and phosphorus-content would be standard as well as the silicon.

With the proposed system it would be possible to specify any grade of steel with any percentage of carbon or manganese that is desired for a given requirement. It would also be possible for all users of steel outside of the automotive industry to apply their particular analyses to the system.

WHEEL MOUNTINGS CRITICIZED

As a result of several criticisms in reference to the wheel mounting recommendation made by the Axle and Wheels Division and now printed on p. F1c of the S. A. E. HANDBOOK, the dimensions specified in the present standard, together with the supplementary dimensions that were approved by the Division at a recent meeting, will be laid out to scale and blueprints of the layout sent to members of the Division for study. If it is found after careful analysis that changes in the present standard or in the supplementary dimensions proposed are advisable, such changes will be recommended by the Division at the Summer Meeting of the Standards Committee.

HARDWOOD LUMBER SURVEY UNDER WAY

With the arrival of two representatives of the Forest Products Laboratories at the plant of the Fisher Body Corporation in Detroit, the program of the Passenger-Car Body Division on the standardization of hardwood lumber in cooperation with the Central Committee on Lumber Standards and its consulting committee was considered to be well under way. The representatives working with R. E. Brown of the Fisher Body Corporation, who is a member of the S. A. E. Subdivision on Hardwood Lumber Standardization, will make a careful survey of the hardwood lumber requirements of his company with the idea of working out plans that may be extended to other body companies in determining the requirements of the automotive industry for factory cut-up sizes of hardwood lumber of body framing.

The lumber standardization program was initiated at a conference held in Washington at the request of Secretary Hoover, the Central Committee of Lumber Standards being organized at that time to formulate American standards for the sizes of lumber and methods of grading so as to place the industry on a more efficient basis for the conservation of the lumber supply through the elimination of the wastage and misunderstanding resulting from present practice. The Central Committee on Lumber Standards is representative of the lumber producer, the jobbers, the consuming interests and the national engineering societies. A consulting committee that is advisory to the Central Committee is composed of representatives of the several branches of the lumber-producing industries, particularly the consuming industries and the national standardization bodies. The Society is

represented on the consulting committee by R. E. Brown, of the Fisher Body Corporation.

To further the work of the consulting committee with special reference to the automotive industry, the Society organized a Subdivision to facilitate the gathering of specific data from the body builders. The personnel of the Subdivision is as follows:

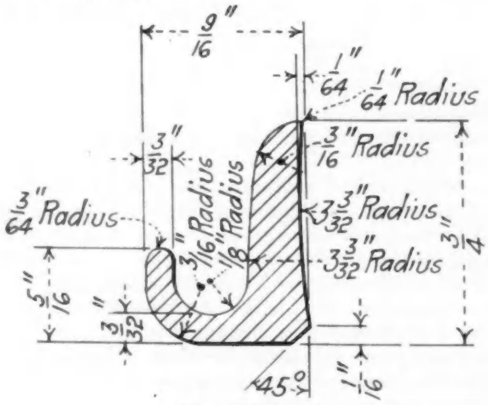
G. J. Mercer, *Chairman*	Consulting Engineer
R. E. Brown	Fisher Body Corporation
R. A. LaBarre	Towson Body Co.
T. J. Litle, Jr.	Ford Motor Co.
F. F. Murray	Hardwood Manufacturers' Institute
J. E. Schipper	Class Journal Co.
A. T. Upson	Forest Products Laboratories

ALUMINUM MOLDING STANDARDS NEEDED

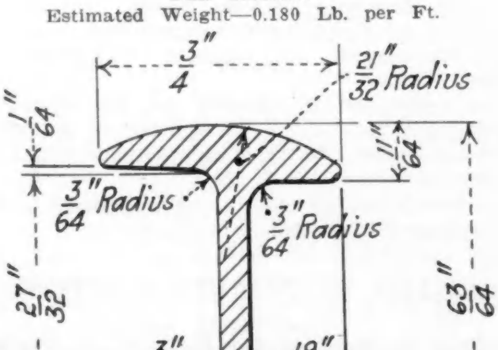
Range of Types and Sizes Now Used Heavy Burden on Manufacturers

The Subdivision on Aluminum Molding, which was appointed by Passenger-Car Body Division in 1922, has submitted a progress report that is given in full in the accompanying tables and illustrations. The report has been submitted for criticism to the body builders and to the passenger-car companies building bodies.

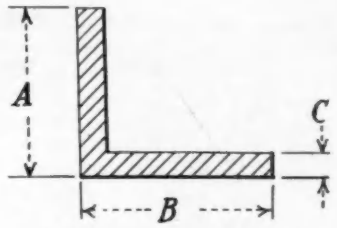
The adoption of standard aluminum moldings in actual production will eliminate the great variety of types and sizes that are used in the industry today and necessitate an unnecessarily large investment in tools and stock which increases the cost of production. The types and sizes of molding proposed by the Subdivision are considered more or less standard at the present time and it is believed that they will meet normal future requirements, the standards being intended for adoption only when changes in production and design economically permit.



DRIP MOLDING
Estimated Weight—0.180 Lb. per Ft.

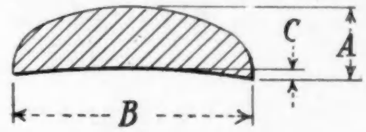


TEE MOLDING
Estimated Weight—0.188 Lb. per Ft.



DIMENSIONS FOR ELL MOLDING

No.	*A*	*B*	*C*	Estimated Weight, Lb. per Ft.
1	¾	¾	⅛	0.238
2	1	1	3/16	0.455
3	1¼	1¼	¼	0.791
4	1½	1½	¼	0.954
5	2	2	¼	1.280
6	2½	2½	¼	1.607



DIMENSIONS FOR BELT MOLDING

No.	*A*	*B*	*C*	Estimated Weight, Lb. per Ft.
1	3/16	⅝	0.019	0.107
2	3/16	¾	0.020	0.117
3	3/16	½	0.019	0.086
4	¼	1	0.025	0.228
5	¼	⅞	0.025	0.186
6	¼	1¼	0.025	0.286
7	5/16	1¼	0.030	0.300

FELT SPECIFICATIONS APPROVED

Thirteen Classifications of Felt Included in Report of Subdivision

Although there has been a wide difference of opinion as to the possibility of formulating practical specifications for felt, the Subdivision of the S. A. E. Parts and Fittings Division that was appointed some time ago to consider the practicability of formulating felt specifications has submitted a preliminary report covering the specifications that are considered to meet the requirements of the automotive industry.

Whether or not these specifications are satisfactory for adoption as S. A. E. Recommended Practice or as S. A. E. Standard will be decided largely by the consensus of opinion of felt users as determined by a general letter that has been sent to passenger-car, motor-truck and axle manufacturers.

> To determine the percentage of wool, the following method abstracted from Sadtler's Industrial Organic Chemistry should be used
>
> Boil a 2-gram sample of the material to be tested in 60 to 80 cc. of sodium-hydroxide solution of 1.02 specific gravity for 15 min., using a reflux condenser. Wash the residue with distilled water until the sodium-hydroxide and the saponified wool are removed, then press out the water, dry in air and weigh.
>
> $$\text{Per Cent Wool} = 100\,(W - 1.05\,w) \div W$$
>
> where
>
> W = the weight of the original sample
> w = the weight of the residue
>
> Since hair and other animal fibers similar to wool will be saponified and included in the resulting percentage, a microscopic examination should be made of the original sample.
>
> All of the above grades of felt shall be free from starch, glue or other artificial binders unless otherwise specified.

TABLE 1—PROPOSED FELT SPECIFICATIONS

Specification No.	Classification	Wool, Per Cent	Remaining Ash, Per Cent	Color	Thickness Tolerance, Plus or Minus, Per Cent
F1	Back Check	100	1.00	White	10
F2	Back Check	100	1.00	Any Color	10
F3	Back Check	95–100	1.25	Any Color	10
F10	Firm Pad	100	1.00	White	10
F11	Firm Pad	100	1.25	Grey	10
F12	Firm Pad	90–95	1.25	Grey	10
F13	Firm Pad	80–85	1.25	Grey	10
F15	Firm Pad	60–65	1.50	Grey	10
F26	Soft Pad	50–55	1.50	Grey	10
F30	Medium Sheet	100	1.25	White	5
F50	Colored Shoe Upper	100	1.25	All Colors	10
F51	Shoe Upper	70	1.25	Grey and Black	15
F60	Asbestos	50[a]	5.00	Grey	15

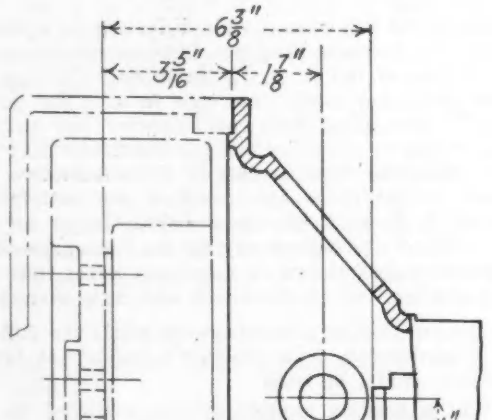
[a] 50 per cent reworked wool and 50 per cent wool substitutes.

TABLE 2—THICKNESS AND WEIGHT OF PROPOSED STANDARD FELTS

Specification No.	Weight of Felt, Lb. per Sq. Yd. Allowable Tolerance, Plus or Minus 10 Per Cent									
	Felt Thickness, In.									
	1/8	3/16	1/4	5/16	3/8	1/2	3/4	1	1 1/2	2
F1	2.00	3.00	3.95	5.10	6.00	8.20	....	....	....	....
F2	2.00	3.00	3.95	5.10	6.00	8.20	....	....	....	....
F3	2.00	3.00	3.95	5.10	6.00	8.20	....	....	....	....
F10	1.50	1.75	2.25	2.75	3.25	4.25	....	....	....	....
F11	1.50	1.75	2.25	2.75	3.25	4.25	....	....	....	....
F12	1.50	1.75	2.25	2.75	3.25	4.25	....	....	....	....
F13	1.50	1.75	2.25	2.75	3.25	4.25	....	....	....	....
F15	1.50	1.75	2.25	2.75	3.25	4.25	....	....	....	....
F26	1.10	1.50	1.90	....	....	....	....	....	....	....
F30	....	....	5.00	....	7.50	10.00	17.50	20.00	30.00	40.00
F50[b]	....	....	....	....	....	....	....	....	....	....
F51[c]	....	....	....	....	....	....	....	....	....	....
F60	....	....	1.50	....	2.25	3.00	4.50	6.00	....	....

[b] Specification No. F50 shall weigh 20 oz. per yd. 60. in. wide when 0.050 in. thick; 22 oz. when 0.055 in. thick; 24 oz. when 0.060 in. thick; 26 oz. when 0.065 in. thick; 28 oz. when 0.070 in. thick; 30 oz. when 0.075 in. thick; 32 oz. when 0.080 in. thick and 34 oz. when 0.085 in. thick.

[c] Specification No. F51 shall weigh 6 oz. per yd. 60 in. wide when 1/32 in. thick; 10 oz. when 3/64 in. thick; 14 oz. when 1/16 in. thick and 18 oz. when 5/64 in. thick.



PROPOSED STANDARD FOR CLUTCH HOUSINGS

All weights shall be based on the thickness of the felt as ordered and no correction in weight shall be made for variations in the thickness of the material received.

The appearance, hardness, and oil-absorption qualities shall be in accordance with a sample of felt approved by the engineering department and retained as a standard by the purchasing and inspection departments.

General Information.—Back check and firm pad felts are recommended for use in washers, bushings, oiling wicks, door bumpers and similar parts.

Soft pad felt is intended for chassis strips. Medium sheet felt is intended for use where a felt harder than back check felt is required.

Colored shoe upper felt is intended for use for ball and roller bearing oil-retainer washers and for use where an accurate, thin, smooth, high-grade felt is desired.

Shoe upper felt is intended for use where a felt thinner than back check or pad felt is required and where the higher quality of colored shoe upper felt is not required.

Asbestos felt is intended for such applications as soft top padding or cushions.

CLUTCH STANDARDS PROPOSED

Housings Satisfactory for Both Single-Plate and Multiple-Disc Clutches

For some time the Subdivision on Clutch Standardization has been considering the possibility of standardizing clutch housings so as to permit interchangeability of different makes of multiple-disc and single-plate clutch. The dimen-

sions, the standardization of which is considered necessary to obtain such interchangeability, are

(1) The distance from the flywheel face to the rear throw-out position of the clutch sleeve
(2) The position of the throw-out yoke for the pull-sleeve type of clutch.

In determining upon satisfactory dimensions, it was recognized that the greater the distance from the flywheel to the rear throw-out position, the greater the weight of the housing, and the consequent overhang of the transmission, which would work a decided hardship on the large producers of small and medium-size cars. A dimension of 6⅝ in. was therefore selected as shown in the accompanying illustration.

The 1⅞ and 1½-in. dimensions proposed for the location of the throw-out yoke were selected as providing a satisfactory position, which at the same time would permit a reasonable pedal ratio for both multiple-disc and single-plate clutches.

Although it is recognized by the Subdivision that the trend among large producers is to make the overall clutch length much less than recommended by the Subdivision, it is considered desirable to present the above recommendation because it would greatly simplify the problems of the transmission and clutch manufacturers and thus work to the advantage of the greatest number of car producers. The Subdivision will, however, endeavor to establish a standard for the short clutch housing.

DOOR-HINGE STANDARDIZATION FAVORED

Comments received from passenger-car body builders in reference to the Subdivision recommendations for door-hinges indicate that with slight revisions the recommendation will be acceptable to the body industry. It is therefore anticipated that the Passenger-Car Body Division will be in a position to make a definite recommendation on this subject to the Standards Committee at the Summer Meeting that will be held at Spring Lake, N. J., June 19.

THE SOCIETY IN AUSTRALIA

THE following letter from the Associated Trade Journals Co. of Sydney, Australia, is of interest as indicating the ever-increasing sphere of the Society's work and the appreciation of our foreign associates of what the Society is endeavoring to accomplish for the industries through the S.A.E. standardization.

Sydney, 2nd March, 1923.

Society of Automotive Engineers, Inc., New York.

We have to acknowledge the receipt of your letter of 15th December, and to advise that the S. A. E. Standards and Recommended Practices duly came to hand, together with the other publications mentioned by you.

We have to thank you sincerely for your permission to reproduce a selection of these Standards, and believe that your help in this matter will be productive of good results both in Australia and in your country; not only will it assist the manufacturing engineer in the growing motor industry here, but it will help to show our people the careful and thorough consideration that has been given to these matters in the United States.

Apart from this will you accept our congratulations, both upon the wide area you have covered and upon the thoroughness with which you have dealt with the many problems.

We are very interested in the work being accomplished by your Society and would like to keep in close touch with your activities. But it is not easy to see just how our activities fit in with a plan of operation. We certainly wish to receive your monthly JOURNAL, and all standards, etc., as issued.

Although Australia, the "South Sea Empire," is not a large manufacturing country comparatively as yet, it is a land of wonderful natural resources and is working toward a leading position in industrial activities. The following figures[1] indicate the rapidly increasing importance of Australia as a prospective buyer of automotive vehicles.

AUTOMOBILES EXPORTED TO AUSTRALIA

Year	Passenger Cars Number	Passenger Cars Value	Trucks Number	Trucks Value
1913	2,083	$1,896,990	17	$23,027
1914	3,099	2,615,896	32	37,378
1915	2,169	1,768,479	57	84,142
1916	5,335	4,147,302	201	295,538
1917	5,055	3,792,571	194	237,159
1918	4,307	3,410,557	109	163,405
1919	3,905	4,016,751	418	565,406
1920	8,989	10,034,626	985	1,436,589
1921	3,020	3,065,890	720	1,194,900
1922	11,236	8,716,930	1,095	1,211,199

[1] These figures were obtained from the National Automobile Chamber of Commerce and do not include New Zealand.

The producers of vehicles exported to Australia bear the responsibility of building into their product units, accessories and materials that will enable the purchasers to get maximum life and economical operation. The servicing of these vehicles in a so distant land is of prime importance and the vehicle builders can render their users the best service in the replacement of parts in the least time and at lowest cost by using the Standards that the Society of Automotive Engineers has been formulating and publishing for many years in the S. A. E. HANDBOOK.

METRIC TIRE-SIZES

A COMPARISON of the statistics of export shipments of automobile tires compiled by the Rubber Association of America, Inc., with the official customs returns for 1922, shows that roughly 75 per cent of the exports are reported to the Rubber Association. Of this 75 per cent, the proportions of metric sizes exported are casings, 24 per cent; tubes, 14 per cent; and solid tires, 20 per cent.

It is said that the tendency is toward the use of straight-side tire equipment on European cars. The thorough adoption of cord tires in metric sizes by leading European builders is a step in this direction, because of the difficulty of making satisfactory extensible beads for cord casings, and the non-extensible straight-side bead is the logical solution. The facts that Rolls Royce has adopted straight-side equipment as standard and that all winners of recent classical road-races used straight-side tires are additional evidence of the general tendency toward the increasing use of this type of tire throughout the world.

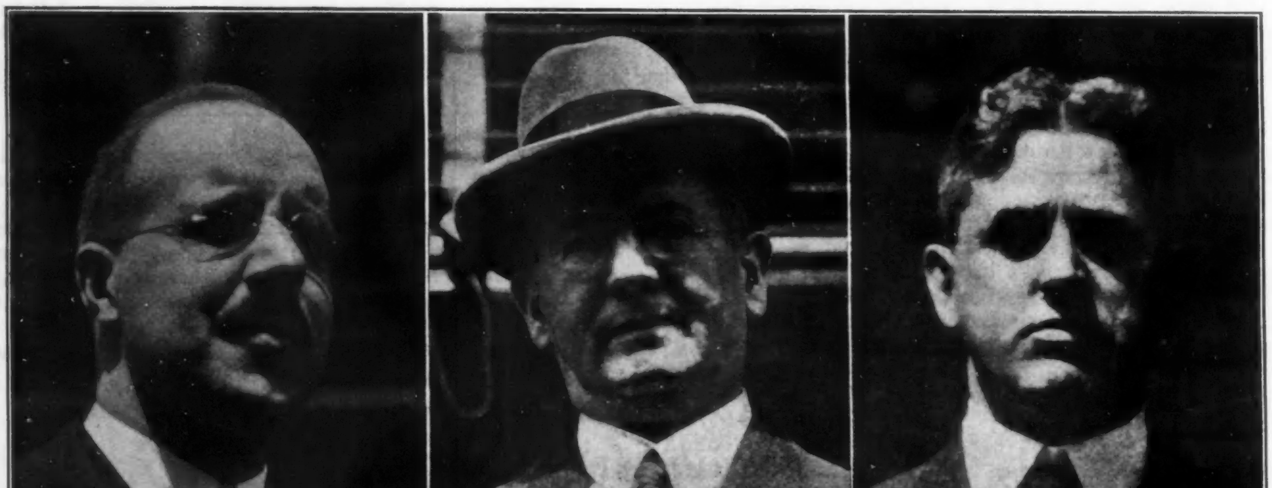
SOCIETY MEETINGS

AUTO TRANSPORT MEETING SUCCESSFUL

Trucking, Bus and Taxicab Papers Reflect Advance of Engineering in Operating Field

The development of sound motor-transport engineering principles received great impetus at the first Automotive Transportation Meeting of the Society in Cleveland April 26 to 28. Close to 200 persons from all sections of the Country and all branches of the transportation field were in attendance. The keynote of the meeting was the promotion of a better understanding between the operators of the railroads and electric railways on the one hand and the automotive industry on the other. It is fortunate that the Society should devote a national meeting to motor-transport problems at a time when the motor truck and the motorbus are just beginning to be accepted as highly valuable accessories to the railroad and the street car instead of being regarded as their pernicious competitors. It was clearly evident, as one listened to the papers and discussion that motor transport is an established arm of the Nation's transportation system; basic fundamentals of operation are not established definitely as yet, but successful applications, such as those described at the meeting, are bringing the problems and their solutions to the surface. This will result eventually in the establishment of automotive transportation engineering as a distinct and important science. The Cleveland meeting represents the Society's effort to interest engineers in the development of this science and to attract into its membership those motor transport experts who are pioneering this development in order that they may be closely associated with the designers and producers of the vehicles used in their operations.

The meeting program included four professional sessions, a group of factory visits and a dinner. Seven of the nine papers read at the sessions are printed in full in this issue of The Journal. The following pages contain a resume of the discussions of the papers and a report of the addresses at the Transportation Dinner.



R. E. Fielder — W. H. Lyford — David Beecroft

THREE PROMINENT SPEAKERS IN THE DISCUSSION

TRUCK AXLE EFFICIENCIES COMPARED

Bureau of Standards Tests Show Triple-Reduction Type Has Lowest Overall Power Loss

The Thursday morning meeting was opened with a paper on axle efficiencies prepared and read by S. Von Ammon of the Bureau of Standards staff. The data and conclusions were the result of an extensive group of tests undertaken by the Bureau for the Motor Transport Corps with the object of determining which type of rear axle was best suited to the service and operating conditions encountered by the vehicles used in the transportation of Army materiel. The tests were limited to heavy axles, capable of duty under trucks of the 5-ton class. Eight axles were tested and included representative worm, double-reduction, triple-reduction and internal-gear types. The tests were made by driving the axles with an electric dynamometer through a standard Class B Army truck transmission rigidly mounted on the field frame of the electric dynamometer. The power output was absorbed by prony brakes at the rear wheels. The differentials were locked during the tests by filling them with soft metal and the brake mechanism was removed to avoid brake-drag losses. Each of the axles was run for a sufficient time previous to the official runs to reduce, as far as possible, any change in mechanical fits during the actual tests.

The influence of oil temperature on the performance of the axles made it necessary to take observations at definite tem-

peratures for each of the test runs. This resulted in the following program of tests being carried out.

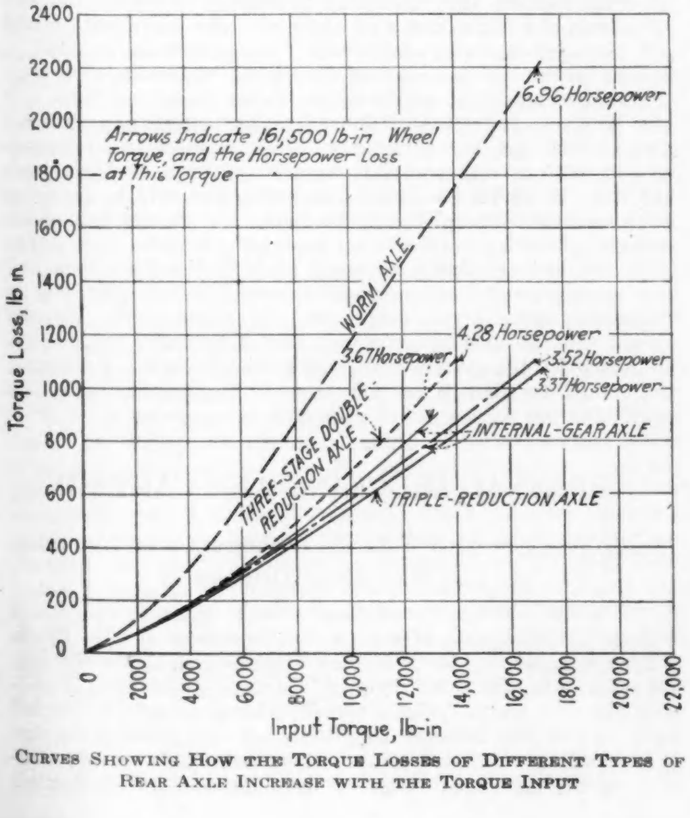
1. Preliminary power runs at 8.5 m.p.h. and various temperatures up to 100 deg. cent. (212 deg. fahr.).
2. Efficiency tests at six different speeds and several temperatures.
3. Temperature-rise run at 15 m.p.h. with a constant load of about 50 hp.
4. Check runs at 2.5 and 15 m.p.h. and a temperature of 70 deg. cent. (158 deg. fahr.).
5. No-load tests at several speeds and oil temperatures.
6. Break-down tests at 2.5 m.p.h. with a constant load of 50 hp. Oil-temperature rise observed.

Government specification lubricant was used and the oil level was kept constant throughout the tests.

In analyzing the results of the tests it was found possible to separate the losses into (a) no-load losses, and (b) load losses; the total losses are the sum of these two. In general, the no-load losses were primarily controlled by the viscosity and the method of applying the lubricant. They were greater in those axles where the parts rotating at high speeds were immersed most completely in the oil. Where a separate body of lubricant was used in the wheels, the losses were still greater. In a given axle these losses are increased with an increase in the viscosity of the lubricant and with the propeller-shaft speeds.

The load losses, expressed as torque, were practically independent of the speed and of the viscosity and the method of applying the lubricant. They increased, however, with an increase of the torque input and at an increasing rate. In the case of the Class B worm-type axles, the increase in the load losses with an increased torque-input was greater than with any of the gear-type axles. The use of a lubricant of a lower viscosity at low temperatures would improve the mechanical efficiency under the more unfavorable conditions of speed and temperature and would seem advisable. Some improvement in the method of circulating the oil is suggested as desirable by the results since the high no-load losses of some of the axles show the present method of circulation to be very inefficient.

The characteristic difference between the worm-drive and gear-drive types is demonstrated by the greater load losses



CURVES SHOWING HOW THE TORQUE LOSSES OF DIFFERENT TYPES OF REAR AXLE INCREASE WITH THE TORQUE INPUT

of the former type. One of the curves taken from Mr. Von Ammon's paper is shown herewith to indicate the torque losses of the different axles with increasing torque input.

M. C. Horine asked why the conventional double-reduction axle, in which the primary reduction is through bevel gears and the final reduction is through a single pair of spur gears, was not tested. Also, why was the chain drive omitted? A. W. S. Herrington of the Motor Transport Corps replied that no axles of the former type were made in the heavy duty or five-ton class. The chain drive was omitted because it is not suitable for Army service in the judgment of the Motor Transport Corps engineers. Mr. Herrington warned those present that the results of the tests must be accepted as applying primarily to military service. The worm axles tested were designed to have a maximum road clearance and this limited the size of the worm gear. In the case where road clearance was not a factor the worm-wheel could be made large with the worm underneath; the conditions demanding low speed and high torque in military service might not prevail; silent operation might be a paramount condition. In such a case, the worm drive axle would appear to much better advantage.

Mr. Von Ammon's paper will appear in full in the June issue of THE JOURNAL.

MOTOR-TRUCK INDUSTRY IS SOUND

Exception Taken to Inference That Trucks Cannot Be Sold and Operated Profitably

In the paper read by S. G. Thompson at the Transportation Meeting exception was taken to the title of a pamphlet published recently by one of the trade papers which read, "What Is Wrong with the Motor-truck Industry?" Mr. Thompson's paper is printed in full on p. 446 of this issue. He reviews the history of the motor-truck industry, and the great changes in conditions of transportation demand are stated as conclusive proof that the motor truck is a permanent asset, that there is nothing wrong with the industry and that, to the contrary, the motor-truck industry is fundamentally right.

David Beecroft, publisher of the pamphlet in question, was present at the meeting and replied to Mr. Thompson in the discussion. He said that the title to the pamphlet had been chosen for the purpose of exciting interest in the text matter that contained no reflection on motor trucks or the industry. It is necessary that opinions be founded on text rather than titles. The text of the pamphlet was based on the user's point of view entirely; it represented an attempt to set down the problems facing the operator of motor vehicles as reflected in responses to a large number of questionnaires sent to 25,000 fleet operators all over the world. It was found that their transport problems are not problems of the vehicle, but are problems of transportation. Maintenance was the problem of 81 per cent of those who replied; organization troubled 74 per cent; cost determination was worrying 72 per cent; operating plans or control of the vehicle on the street interested 72 per cent; selection and handling of drivers was the problem of 69 per cent. This indicates that these operators are satisfied with their vehicles as a transport tool, but they are troubled with problems of organization and operation.

Later reports show that the problem of personnel stands highest; training and supervising drivers, loaders, helpers, inspectors and mechanics. Yesterday, under the horse ré-

gime, the horse was the yardstick by which a day's transportation service was measured. Fifteen miles was the limit of his daily travel and the driver's initiative counted for little. We now have a vehicle that, if properly maintained, can be operated nearly 24 hr. each day. The capacity of this new unit is limited only by the efficiency of the organization that sets it to work and keeps it working. This condition puts the burden of success on the choice and training of the proper personnel. Mr. Beecroft offered an apology to the industry for anything that might have been said in the pamphlet that could be construed as insinuating that the motor-truck industry was falling backward.

SUCCESSFUL RAIL-TERMINAL HAULAGE

Operations of St. Louis Firm Using Tractors and Semi-Trailers Described

A system of automotive transportation for intra-city hauling and the movement of freight between railroad terminals that has proved successful in St. Louis was described by J. F. Murphy in a paper read at the Thursday morning session of the Transportation Meeting. This paper is printed in full on p. 467 of this issue of THE JOURNAL.

A. F. Masury opened the discussion of Mr. Murphy's paper. He said that this operation represented a fitting example of the logic of fitting the truck to the business and the business to the truck. The success of the Columbia Terminals installation could be credited to four conditions; first, the hauling is done over routes between definitely located points and at a nearly uniform speed; second, the grade conditions are not severe; third, the loads carried are fairly near the full capacity at all times; fourth, the tractors are kept busy nearly all the time by the dispatching system used. The operation of gasoline-propelled tractors in connection with semi-trailers has received little support from truck builders. The possibility of being able to transport two to three times the load capacity of a truck without changing the power unit is most inviting, but there are many difficulties met in carrying the plan into operation. Many of these follow as a result of imperfections in the tractor, the trailer or the connection between the two. Mr. Masury felt that the future for such equipment does not lie entirely in city work, especially in view of the present tendency in highway legislation. The important thing to keep in mind is that the tractor-trailer combination will come within the requirements of highway laws, up to a much greater payload capacity than the four-wheel truck. Trailer brakes are essential to successful operation. Grade conditions must be surveyed carefully, and the prospective load capacity determined accurately, before choosing equipment for interurban work.

Francis W. Davis said that there were a dozen other cities where conditions warranted the establishment of installations similar to that in St. Louis. It is reported to cost $35 to deliver a car in the Borough of Manhattan, New York City, after it has reached the Jersey City terminal. The very magnitude of the problem, along with the desire for cautious procedure until the most practical and lasting system has been developed, probably furnishes the inertia that prevents the immediate institution of adequate intra-city transfer motor lines in the New York City area. Mr. Davis compared the St. Louis or semi-trailer plan with the installation in Cincinnati, which is operated on the demountable truck-body plan, and cited the following advantages that led him to favor the St. Louis system:

(1) Capital invested
- (a) Motive power in relation to tonnage capacity
- (b) Terminal costs, both on-track and off-track
- (c) Extra cost of trailers as compared with unit bodies is probably offset entirely due to the heavy construction necessary with unit bodies and the necessary overhead apparatus at all terminal points for handling

(2) Operating expense
- (a) Decrease in insurance of motive power in relation to tonnage capacity
- (b) Decrease in fuel consumption in relation to tonnage capacity
- (c) Decrease in labor cost both in relation to motive power and at terminals
- (d) Decrease in upkeep and maintenance of motive power in relation to tonnage capacity

(3) Flexibility
- (a) Saving in time at terminal points as driver controls picking up and letting go of semi-trailers from the seat
- (b) Takes up less road space in relation to tonnage hauled
- (c) Increasing rather than decreasing platform space

The one point wherein the unit demountable body seems to have an advantage over the semi-trailer is in the proposed shipment on line-hauls of the loaded bodies or unit containers, thus obviating terminal labor costs and other handling expense. Mr. Davis was of the opinion that, even here, there was nothing to prevent lifting the body from the semi-trailer as used at St. Louis. He considered that users of motor-truck equipment in other fields than terminal haulage will do well to study the results obtained in St. Louis, as the tractor-trailer unit stands ready to effect economies and handle tonnage far beyond the results accomplished to date.

Asked regarding the possibilities of night service, Mr. Murphy replied, that this was impractical because the rail terminals did not operate at night and the merchants would not be open to take deliveries. His company is able to handle 80 to 90 per cent of the total interchange of less-than-carload freight reaching St. Louis from the East and the West, so that it is delivered to the connecting railroad and started out the same day. This enables the railroads to get efficient and complete loading of cars and increases the area in which St. Louis merchants are able to carry on business. Mr. Murphy did not favor the demountable-body scheme of motor haulage in his work because the bodies took up loading platform space at both the terminals and the warehouse. Just as soon as the loading platform is congested, costs begin to mount. In closing, Mr. Murphy stated that he and his engineer, Mr. Englander, who is responsible for the system employed by the Columbia Terminals Co., would be glad to contribute anything further that they could, for the advancement of motor transportation.

TERMINAL TRUCKING AND CARTAGE

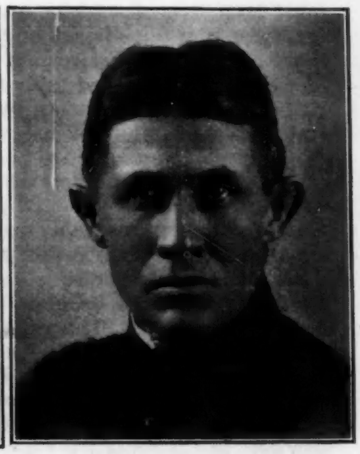
Motor-Truck Session Takes-Up Congestion at Terminals and Store-Door Delivery

The second Motor Truck Session was called to order at 2 o'clock on Thursday afternoon by Chairman F. W. Davis. The first paper, by F. C. Horner of the General Motors Corporation, who discussed English Cartage Practice, a Standard for Our Railway-Terminal Trucking, is printed in full on p. 437 of this issue of THE JOURNAL. In opening the discussion of Mr. Horner's paper, Chairman Davis called attention to the advanced stage of development of the English

system of handling terminal shipments and from store-door to terminal traffic. He referred to the fact that Elisha Lee of the Pennsylvania Railroad system had voiced the sentiment at the annual dinner of the Society that the railroads of this Country at least are very much opposed to the possibility of having this operation, which implies ownership, forced upon them, and inquired whether the service had been forced on the English railroads or they voluntarily took it over as a profit-returning venture. Mr. Horner replied that the English railroads were not required by law to adopt it but that they were forced to do so because they could not get service from the existing cartage agencies. He does not advocate the owning of such equipment by the railroads in this Country. With regard to handling l. c. l. shipments and parcel post and express shipments in the same individual carriers, Chairman Davis suggested that an obstacle probably would be met with, in that the railroads are required to make express shipments in baggage cars. They cannot truck the goods from the city to a suburb or an outlying town. They must actually put it into a baggage car, transport it and rehandle it at the other end. Replying to a question with regard to the use of unit containers Mr. Horner suggested that these were only practicable for regulated loads, in other words, when the same quantity of goods is shipped in both directions between the consignee and the consignor. It is not practicable if the goods must be picked up at 15 or 20 different points in one locality, and delivered at 15 or 20 other points in the second locality. In order that the container plan may be used to advantage, there must be the closest cooperation and coordination between the shippers, the railroads and the cartage interests. Unit containers would be of especial advantage when goods must be transferred several times on the way; in such cases it would avoid their being handled piece by piece.

A. J. Slade stated that actually to secure a real and sensible improvement in the present chaotic and extravagant methods, the various interests concerned in efficient transportation must be brought to a realization that one or the other interest must take the initiative in preparing a definite plan for the coordination of transport operations. In 1912 during a visit to England, he had found that the British store-door delivery system was firmly and permanently established, that in talking with one railroad official, who had just returned from a visit to the United States to investigate the use of motor vehicles by American railroads, this official had been surprised to discover that our railroads had not given the matter especial attention. Mr. Slade attributed this to the fact that the rapid growth of the population in the United States had directed the energies of the railroads toward the extension of their lines in newly settled communities and toward providing for the continually increasing traffic on existing lines; whereas in Europe where increases in the population are not occurring, the railroad companies have had more opportunity to devote their energy toward improving the service. During the last year, while in France, his personal experience had been exactly opposite to that cited by Mr. Horner, in connection with a shipment from Baltimore to New York City, a shipment made from a small town near Nice having been received at his apartment in Paris on a single bill of lading, and the payment of all charges being made when the shipment arrived at its destination.

W. H. Lyford said that high pressure of the industries seems to bring out the importance of real transportation when a shortage of cars and the delays of transportation begin to limit production, that the paramount need of adequate transportation is brought home to the producing industry and that there is a general recognition of the fact that industries and traders generally are interested more in adequate transportation than in cheap transportation. An understanding of the importance of transportation to industry ought to lead to the public's approval of any measures that would lead to an increase in the efficiency of the transportation system and impress the public with the fact that the credit of a transportation system must be assured and maintained in order that the railroads may add to their facilities measurably with the increase of the traffic. He said that he approved all Mr. Horner's views, but that Mr. Horner in de-



F. C. Horner Major Brainerd Taylor

Authors of Two of the Papers Presented at the Second Motor-Truck Session

scribing how each railroad company in Great Britain has its own cartage system in each terminal area and that the collection and delivery is contracted for and performed by the railroad company, had left out two important facts: first, that such cartage service is paid for by the traders and is a separate charge that generally is made part of an inclusive rate for complete transportation from the store-doors of the shippers to the store-doors of the consignees, but that need not be paid if the trader prefers to perform his own cartage service. Although the use by the trader of the collection and delivery service operated by the railroads in Great Britain is voluntary, the organized cartage service operated by the railroads is cheaper than such service could be performed by the traders, and therefore it is accepted generally by them and insisted upon; in the second place, he would seriously oppose any attempt by American railroads to carry on a cartage service. The operation of motor trucks is a comparatively new industry. During the short period of about 13 years it has developed experience and efficiency, but American railroad organizations have no knowledge and no experience in this field. On the other hand, British railroads began collection and delivery more than 50 years ago, and they have developed within their organization separate departments under cartage managers, that have produced experts and high efficiency. His experience with railroad organizations and their activities have satisfied him that when a railroad organization undertakes an outside activity the result is a failure. The railroad finds itself unable to compete with those organizations that have devoted their entire attention to those activities and have had the experience that the railroads lack. Three London railroads in 1912 determined that one cartage organization could serve all three of them more economically and efficiently than they were being served by three separate companies. Accordingly, they selected a cartage expert and turned over to him all their cartage facilities in London, allowing him to perfect his own organization; and immediately there was an increase in efficiency, in economy and in service. A further development covering all the railroads in London was interfered with by the war and has not yet become effective. As the collection and delivery service must be paid for by the traders it should be made as efficient and as economical as possible and the highest economy and efficiency can be obtained best by a single organization in each railroad terminal area. It must be wholly impartial in its treatment of the various traders and the different railroads, and therefore should not be controlled by any railroad or by all the railroads, but should be an independent organization working in the closest harmony with the railroads. Without full cooperation with the railroads the collection and delivery of goods will not produce the one great result of which it is capable, namely, the free movement of freight through railroad terminals and the prevention of congestion that limits the volume of railroad traffic. To avoid congestion of the station platform there

must be a line of vehicles or containers to which all freight from the long line of freight cars can be trucked directly, and those containers must remain until the train is unloaded, unless they have received their full load in the meantime. The British meet the situation by lining up their lorries at the station platform but release the horses and the drivers while the lorries are standing to be loaded or unloaded. American efficiency would not allow slow-moving horse vehicles to be used for this service, for in all large cities the horse-drawn vehicle adds unreasonably to street congestion and the automotive vehicle is absolutely necessary. A motor truck is economical only when it is kept moving; therefore, in a majority of cases, the ordinary motor truck is not economical for station service. This difficulty has been solved by designing, building and operating a demountable body and a semi-trailer or trailer. Walter White and his lieutenant, B. F. Fitch, are entitled to the credit of proving the efficiency of the motor truck with demountable bodies for railroad station service. In Cincinnati the use of 15 chassis and 225 demountable bodies has displaced thousands of freight cars and released them for line hauls. The efficiency and economy of the semi-trailer for railroad station service has also been demonstrated by Mr. Childress between East St. Louis and the stations and traders in St. Louis. A comparatively inexpensive demountable body, or semi-trailer, can stand this delay at the railroad station, and the expensive tractor and driver can be kept moving.

There is also great need for a system of cartage control. At Cincinnati where the system has been developed to the highest degree, the despatcher is in constant touch with his drivers and moves them exactly as a train despatcher controls the trains on each division. Whenever a truck body is completely loaded the despatcher sends the most available driver to remove it and replaces it with an empty body or an outbound load. One British station was used three different times in 24 hr. for three entirely separate operations, whereas in America three different stations are required for the same service and to handle the same volume of freight. The British freight service, supplemented by adequate cartage, makes unnecessary the express company and the heavy parcel post, and is superior to our present express and parcel post service. All freight collected in London, Manchester or Glasgow before 5.00 p. m. will be delivered to the consignee at his store-door before noon of the following day at any destination within 200 miles of the shipping point. The merchandise freight service of American railroads is even more efficient than those of the British railroads but the difficulty is that there is no adequate delivery service to transfer the freight from the car to the consignee. Merchandise that is delivered before 5.00 p. m. at a freight station in any large American city and is destined for points on the main lines of railroads within 250 miles will be standing at the destination ready to be unloaded early the following morning, but after the freight arrives the agent must telephone or send a postal card to the consignee, who is allowed 48 hr. from the following morning within which to take delivery of the freight. In Great Britain the freight would be delivered to the door of the consignee before the postal card could reach him. In Mr. Lyford's judgment there is no way in which the adequacy, efficiency, and economy of transportation can be increased so much and so quickly as by the adoption of such organized collection and delivery service.

Illustrating the economy of money and of time that may be effected by the short haul of the motor truck, Mr. Horner cited an instance, in which this service has recently been put into operation by the Pennsylvania Railroad. The railroad has been taking care of a certain section of the Eastern Shore of Maryland by shipping goods to Wilmington, Del., then over the New York, Philadelphia and Norfolk Railroad to the Eastern Shore. This took anywhere from 2 to 3 days, sometimes 4 days. The railroad has now worked out a system whereby they load this traffic on a boat at night at Baltimore, take it down to Cambridge, Md., unload it there and distribute it to the various towns by motor truck, delivering it the following day, much of it by 4 o'clock in the afternoon. The trucks that make the delivery pick up loads, bring them in, and the reverse movement takes place to Baltimore and other points. Mr. Horner called attention to the fact that the railroads are concerned just now with the addition of cars and locomotives to their equipment, but that it is not lack of equipment of the railroads that is causing the delay but the congestion at the terminals that act like the neck of a bottle. If the terminals could be cleared the number of cars and locomotives needed to handle the same volume of traffic could be reduced and the cost also would be less. In England although the railways cart 80 per cent of the l. c. l. traffic themselves, the charges are arranged so that they include both the rail charge and the cartage at both ends.

If the trader takes it upon himself to collect the traffic and bring it to the station or to deliver the traffic from the station, he asks for a rebate. Under the Railroad Act of 1921 this system will be done away with. The charges must be divided into the straight rail charge and the cartage charge, given separately. If the trader thinks that he can make the collection or delivery more economically than the cartage charge by the railroad he may do so.

Mr. Horner said that in the city of London horses are largely used, that the streets are so narrow and so crooked that it is almost impossible to use motor trucks of any size and that the stations are very close together so that the haul is short and the stops are frequent.

Mr. Galvin speaking from the viewpoint of the Haulers Association said that the trouble was largely because of delay by the shipper and suggested that a committee should investigate some of the troubles with a view to preventing the delay. He expressed the desire of his association to cooperate in the efforts to systematize the delivery of freight in large cities.

H. M. Crane remarked that although certain members of the Society like Mr. Lyford's unqualified statement that the railroads are not interested in extending their transportation beyond their present freight terminals it seemed to him to be very desirable that there should be a complete transportation service to the door by one organization; that if automotive engineers would work out a trucking system that would be certain and economical in operation, the railroads would undoubtedly be more ready to take it on as part of their own work. He considered the trucking service in many respects very similar to taxicab service but did not think that anyone felt that the railroads should handle their own taxicab service.

Mr. Lyford replied that he did not wish it understood that the railroads objected to having an organization that would perform complete transportation from the store-door of the shipper to the store-door of the consignee; that the advantages of parcel post service and of express service were obvious; that the immense growth of both compared with that of the freight service was positive proof that shippers realize the advantages of a collection and delivery service and of a complete transportation contract. He hoped that such a system would be evolved but he did not think it would be possible to have it accepted by the people of the Country if it were put forward by the railroad companies. He said that he had emphasized the profitable features of this service to make it attractive so that some one else would take care of it. He believes that in this Country there should be a great nation-wide organization that would undertake to perform complete transportation from every shipper, at least those in communities of more than 2000 to 3000 people, to every consignee in a similar community, would contract for it all the way, furnish the cartage at each end, pay the railroad company its regular rate for the rail part of the transportation and cooperate closely with the railroad company so that the greatest possible amount of freight might be passed through the terminals.

Replying to Mr. Horner's question as to whether it would not be to the advantage of the railroads to furnish cartage service at cost if it would serve to move traffic faster through the terminals and reduce the cost of handling, Mr. Lyford said that as an economic problem he believed that it would be advantageous to do so, but that whenever the railroads had furnished additional facilities they were forced to absorb the cost, and that it would be absolutely impossible to persuade American railway managers to undertake such service.

In closing the discussion, Mr. Horner noted that the English railroads maintained their cartage service because of its advertising value. The competition between the various railroads in England is very keen, and one of the greatest advertising agencies that they have is these vehicles scattered through the streets of the cities with every driver soliciting traffic for his own railroad. He believes that, in analyzing the problem from all sides, this feature should not be lost sight of.

STREET RAILWAY AND BUS OPERATION

Electric Railway Executive Explains How One Must Supplement the Other

The Friday morning professional session at the Cleveland Transportation Meeting was devoted to the motorbus. The Society was fortunate in having the principal talk at this session given by C. D. Emmons, who is president of the American Electric Railway Association and able to speak authoritatively for the street railway men of the Country. Mr. Emmons is also president of the United Railways & Electric Co. of Baltimore, in which capacity he directs the coordinated operation of electric surface-cars, gasoline motorbuses and electric trackless-trolley buses. Mr. Emmons centered his remarks upon the coordination of motorbus and motor-truck service with transportation upon rails. His paper is printed in full on p. 433 of this issue of THE JOURNAL.

President Alden expressed the opinion that population, factories, recreation centers and stores should be scattered instead of concentrated or centralized as they are at present. He deplored the common practice of drawing building activity to the route of each new artery of transportation immediately its route is set. This often leads to the overtaxing of the passenger capacity of the new line, even before it is placed in operation. Mr. Alden is a member of the Rapid Transit Commission of Detroit and he said that that body intended to break up the concentration of population in that city if it was at all practical. The big transportation industries have not all had an equitable deal from the public in the past, but we are entering a 10-year period when the public utilities and the railroads will receive fair treatment and the automotive industry must be in accord with this new attitude.

FIFTH AVENUE BUS EXPERIENCE

An informative and well prepared discussion of Mr. Emmons' paper was read by R. E. Fielder of the Fifth Avenue Coach Co. He took issue with the statements in the paper relating to the ability of the motorbus to handle mass transportation. The estimate of bus headway and passengers carried on Fifth Avenue as based on the count taken by Mr. Emmons' representatives, did not take weather conditions into consideration. He selected a day in the month of March when climatic changes are problematic and bus headway is governed accordingly. Allowance must also be made for the fact that no standees are permitted in Fifth Avenue bus travel and this reduces bus capacity when it is compared with the street car, where standees are carried in large numbers. Mr. Fielder cited the following figures as being averages over extended periods of time: during the morning rush, an average of 183 buses operated south on Fifth Avenue during 1 hr. at the point where Mr. Emmons took his observations, the headway being 19.6 sec. This is equivalent to transporting 9333 persons in an hour. The Fifth Avenue buses carried 52,000,000 passengers in 1922; on the high-record day recently, they carried 269,509 passengers and this was reduced the day following to 180,000 persons because of rainy weather. This illustrates why it is unfair for Mr. Emmons to base his figures on a count taken on a particular day in March without regard to traffic and weather conditions.

ADVANTAGES OF MOTORBUSES

Mr. Fielder read his version of the 14 points of bus superiority. The foremost of these is undoubtedly the flexibility of the unit, since it does not need rails on which to operate and can be switched from thoroughfare to thoroughfare at will; also, because it loads and unloads at the curb, allowing other traffic to pass at its left; there is no tie-up of traffic as in the case of the street car, that is usually in the middle of the street and stops all traffic while it takes on or discharges passengers. The motorbus is independent of a central powerhouse. Should any mechanical breakdown occur, the disabled unit can be placed to one side without tieing up the whole system. Elevated structures and overhead wires are unsightly and the motorbus does away with them. Streets are not being torn up continually for laying or replacing car-tracks.

Municipalities will find it to their advantage to franchise properly organized and reputable corporations to render bus service rather than to hand out the right promiscuously to fly-by-night companies and jitneys, whose sole object is to give service only at rush hours and not throughout the day and the night. Mr. Fielder said that the Fifth Avenue company pays taxes that are proportionately as heavy per unit as those of any street railway; all taxes, city, state and federal, amount to $2,000 per vehicle operated. The Fifth Avenue Coach Co. has built and discarded 19 types of bus in the past 8 years. In the next few years we shall witness a transformation in the bus industry, for it is still in its infancy; many innovations will be introduced that will place the motorbus on a par with the electric railway and the steam road. All three systems will work side by side in bringing this about and each in the end will render a service that is indispensable.

ELECTRIC RAILWAYS SHOULD GRASP BUS OPPORTUNITY

W. P. Kennedy presented a very able discussion that brought out some novel ideas. It was his opinion that the railways should not assume that they are under oppression due to the advent of the motorbus; rather, they are to look upon this event as the forerunner of a greater opportunity than they have ever had in their experience. Instead of dwelling upon the temporary irritation, the motorbus should be studied as a magnificent opportunity for expansion, primarily on the part of the railway industry and secondarily, for the automotive industry. The street railway is in difficulty largely because it has been a non-competitive business; its executives have assumed that nothing would ever displace them. They have gone ahead without meeting demands for the kind of economy that has been forced upon the automotive industry due to competitive conditions within that industry. They proceeded in the direction of building heavier and more luxurious cars and have developed structures, in some instances, that weigh about 80,000 lb. They are now being forced to consider vehicles of the lightest weight to carry the greatest load and have perfected cars weighing 28,000 lb. that perform the same service as the heavy units with a very marked reduction in operating expense.

The motorbus and the motor truck represent a golden opportunity for the street railways to free themselves of many of their present incumbrances. They have been tied to the track and made the mark of all legislative restrictions; the flexible vehicle in the form of the motorbus offers them the way out of many of their difficulties: It was not Mr. Kennedy's opinion that the street railways could entirely rid themselves of all their present incumbrances, but they can have a condition of operation paralleling competitive operations. It will be very foolish for the street railways to assume the attitude of forcing the very restrictions that

have retarded the expansion of the street railway industry on the motorbus industry, only to find that the boomerang will return to themselves eventually.

Can Street Railways Handle Freight?

The railroads are suffering from a want of urban transportation facilities and seek a solution of the store-door delivery problem; the street railways are suffering from an inadequate return upon their investment, yet the street railways possess splendid personnel and facilities for performing additional transportation activity. Mr. Kennedy asked why it is not possible to have an alignment of these two means of transportation with advantage to both and to the public. He believed that it would not be difficult to build an automobile that could operate on a trolley system with its relatively cheap source of power, and at the same time operate independently with gasoline power. The application of such a vehicle would immediately give the street railway companies an opportunity to restore lines that had been abandoned because the district traversed had changed from a residential to a commercial character.

The fact should stand out forcibly that the street railway industry is dependent upon the automotive industry for the solution of its equipment problem in this new extension of its service. The automotive industry, by close counsel and cooperation with the railway industry, must provide equipment to meet the new service requirements. Such expansion presents a great opportunity to the automotive industry because the railways represent prospective customers who are intelligent operators and purchasers requiring products that must be more or less standardized. The automotive engineer also has a great opportunity placed before him in the design of flexible vehicles of a new character beyond the capacity of those now furnished.

F. C. Horner voiced the opinion that ruinous and wasteful competition between the street railway and the motorbus companies must stop. If we intend to solve our transit problems satisfactorily, and with some degree of permanency, it must be done through cooperation and coordination. The trolley car line is the backbone of the present transportation system, but there was some question in Mr. Horner's mind whether this would be the case in the future. The trolley car as it is being operated in very many of our cities today is one of the biggest influences in retarding the speed of street traffic. To speed up street traffic, congestion must be reduced and accomplishment of this will react against the trolley car. R. E. Plimpton of *Bus Transportation* said that his contact with the street railway operators had shown him that they were in the field for a well-tried design of bus that could be bought complete. They do not want to rebuild or reproportion the unit after it is purchased; nor do they want to purchase and install additional equipment. Mr. Plimpton felt that it is up to the automotive engineer to develop real buses designed for the service of the street railways. The latest figures that he had available indicated that the number of buses operated by street railways would be doubled during the current year. The knowledge that the street railways are rapidly acquiring should be of great help to the automotive engineers in solving such pressing problems as the design of brakes and transmissions for motorbus service. Bodies are also due for improvement in the way of lighter weight combined with greater strength. Most of the electric railways maintain complete shop equipment to handle renewals and make repairs; most of them have well equipped wood-working and painting shops, and many of them are equipped to rebuild their equipment entirely. This means that they will be in possession of very valuable maintenance experience that can be passed on to the automotive engineer.

Mr. Plimton brought out the point that the electric street railways are able to determine their costs of operation very accurately. He felt that their entrance into the bus operating field would mean that reliable cost statistics would be compiled and published on the operating expense of motor vehicles. It is especially important that those interested in the extension and development of motorbus service keep an eye on legislative matters. Many of the laws now being passed are so inflexible in their requirements that they are impracticable and should never be passed.

F. E. Sanborn, secretary of the Cleveland Akron Bus Line, said that the foremost problem before the bus operators in Ohio has been the destructive legislation set up by some municipalities in opposition to the operators of motorbuses. In every instance where he had been able to ascertain the source of this legislation, he found it had been brought about or induced by electric railways who wanted to put the bus out of business. He believed that the electric railways were wrongfully blaming the motorbus for their troubles in many instances where this was unjustified. In his own instance, the electric railway between Akron and Cleveland was in a stronger position financially than other lines in Ohio that were not paralleled by motorbus lines. It was his belief that motorbuses do not draw the large part of their patrons from the trolleys; they are people who have not been using any means of public transportation. Two of the largest problems facing the motorbus operator are the matter of proper financing and the setting up of an efficient organization. Mr. Sanborn favored the continuance of bus operation by the pioneer bus operators and not turning the field over to the electric railways. The electric lines are all heavily in debt for their present equipment and if they start the operation of the bus lines and abandon their present plants, the bus system will be called upon to bear this financial burden of liquidation.

Mr. Emmons replied to Mr. Sanborn by saying that some of the electric railways had been backward about bus development but that he had advocated the uses of buses for many years and had pioneered their operation by an electric traction company in parallel with its trolley cars. He was not sure that he could see the fairness in allowing a bus operator to parallel an interurban line in a competitive way, using a rural highway that the traction company had helped to build through its taxes, and taking from that traction company the best portion of its business without being subject to service, fare or tax regulations that placed the bus in at least the same status as the electric railway.

DEPARTMENT-STORE PARCEL DELIVERY

Phases of the Distribution of Light-Weight Packages Usually Overlooked

Harold B. Wess, of R. H. Macy & Co., Inc., New York City, in his paper, which is printed on p. 465, described the last contact that is had with a customer in the delivering of parcels. Mr. Wess said that he was interested in the reasons that had been given by a previous speaker for the use of horses in London. A salesman had recently talked to him about the speed of making delivery, not realizing that in the department-store business it was not the speed with which the vehicles traveled but the length of the stops that was most important; that the vehicle stops most of the time and that when it moves, it moves only for a minute or two. He said that the horse might eventually be done away with but that such a contingency would not happen until engineers had perfected a motor vehicle sufficiently light to operate as cheaply as that drawn by a horse. Replying to questions concerning the average time per stop, the average weight per delivery, the average miles per hour, and the like, Mr. Wess stated that an electric vehicle would probably cover 20 to 25 miles in a day of 8 hr. but that mileage enters only when the distance is from 30 to 50 miles per day in the suburbs. The length of the stops varies from ½ to 2 min. The question of weight is not essential as the articles delivered are mostly parcels.

Special bulk delivery is used for groceries and house furnishings. Probably the heaviest article in parcel delivery is a can of vegetables. The plan of rating the parcels to be distributed by department stores by weight and size has been outlined and the stores have been urged to adopt the classification. Two-ton trucks have been used but this capacity is excessive. What the stores need is a truck as light as can be built.

In closing the discussion Chairman Davis likened the motor-truck for department-store delivery to an illiterate immigrant arriving in this Country, who possesses potential usefulness, rugged strength and ability but who needs considerable training, direction and control before results can be attained that will amount to anything.

Major Brainerd Taylor of the Quartermaster Corps described the Military and Commercial Highway-Transport, his paper being printed in full in this issue of THE JOURNAL, commencing on p. 413. The brief discussion that followed was participated in by Chairman Davis, A. J. Scaife, B. B. Bachman, Col. E. S. Stayer, Mr. Krum and Major Taylor.

TAXICAB CONSTRUCTION AND OPERATION

Strong Bodies Needed—Large Cross-Section Tires and Four-Wheel Brakes Desirable

The Friday afternoon session, at which A. J. Scaife presided, was devoted to the presentation and discussion of papers on taxicab bodies and the construction, maintenance and operation of taxicabs.

H. G. Bersie, in submitting his paper on taxicab body construction, said that there were on Jan. 1 of this year at least 110,000 taxicabs in operation, and that these run 50,000 miles per year each on the average. He pointed out that the quality of the body depends upon its skeleton, the main sills carrying the weight of the whole body as well as that of the passengers. He expressed the opinion that a taxicab body should be 50 per cent heavier than a passenger-car body of the same size. The body of the former type is reinforced with iron over the wheel housings; a very substantial rear door is necessary. Mr. Bersie gave many interesting facts and figures in his paper, which is included in full in this issue of THE JOURNAL.

H. G. Bersie R. H. Croninger
SPEAKERS AT THE TAXICAB SESSION

Paul H. Geyser, of the Yellow Cab Mfg. Co., who was scheduled to present a paper on taxicab construction, maintenance and operation, was unable to appear. R. Harry Croninger, of the same company, presented the paper with interpolated discussion that was keenly listened to. Mr. Croninger said that his company is using a brake-lining which gives 40,000 miles of service. On a rainy day as many as 10,000 telephone calls are received in one hour by the company, which has 500 miles of its own telephone wires and the largest commercial switchboard in the world. The company operates 1700 taxicabs in Chicago. Among the many interesting maintenance items is the washing and fumigating of a cab in 40 min. The practice of the company is not to drain the engine crankcase oil periodically, but to make "finger" tests of the actual oil in the crankcase frequently to judge of its viscosity.

Perhaps the principal point Mr. Croninger made was that designing, operating and maintaining a taxicab are essentially different from corresponding procedures in connection with other automotive vehicles. There is a 400-lb. frame in the larger cab, which weighs 4000 lb. and carries two people 90 per cent of the time. A frame of the same weight is used in the 3200-lb. cab. Ten-gage steel is used in the running-boards and 14-gage in the fenders.

Mr. Croninger said that the best gasoline economy is obtained with 5-in. tires, the use of these resulting in a reduced variation of the vehicle speed in going over tracks and cobblestones. He expressed the opinion that it is very desirable that a successful four-wheel brake system for taxicabs be developed. He said that there is much advantage in using a rational size of "big-diameter" tire, a test having shown that a cab skids less with tires of 7-in. cross-section.

Of course, it is essential that no feature of design enter into the construction of a cab that would tend to interrupt its continual operation. The accessible location of all bolts and nuts and the ease and rapidity with which units can be exchanged are as important as the character of the assembly units themselves. In designing a cab serious consideration must be given to what it means to an operator to remove a radiator or front cross-member and what this represents in actual time for disassembling when this requirement is applied to every other point about the cab. Accessibility is as important as dependability. In the practice of the Chicago company 20 min. is allowed for replacing a spring and 40 min. for removing and 50 min. for reinstalling an engine.

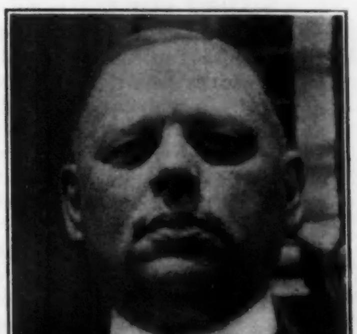
In 1922 the Chicago Yellow Cab Co. employed 3200 drivers to operate its 1700 cabs. The passengers carried numbered over 19,000,000, the distance they were carried being over 67,000,000 miles. Approximately 51,000 passengers were carried every day in the year, or 32 passengers per day per cab. The company maintains 10 combined service-stations and garages in Chicago. Eighty per cent of the entire equipment of the company operates 20 hr. each day, in two shifts.

The driver-personnel of the company is of a very high standard, the expense of employing and training a driver being about $200. Many advantages are accorded the men, including the maintenance of a benefit association. The company assists them in the purchase of its stock; about 35 per cent of the stock is owned by employes.

The modern cab, of course, plays an important part in transportation. The operations of the Yellow Cab Mfg. Co. are undoubtedly conspicuous among the most highly developed and remarkable activities of a similar kind in the automotive field. During January of this year its fleet of cabs traveled over 6,500,000 miles. The maintenance cost, including material, labor and burden, was $0.0084 per mile. About one-third of this fleet had traveled over 200,000 miles.

THE RAILROADS AND THE INDUSTRY

Relations Existing Between Them Discussed at Cleveland Transportation Dinner



It is usual to expect an atmosphere of enthusiasm and good fellowship at the dinner meetings of the Society as they occur from time to time, and for those in attendance to anticipate pleasurably the important information that is certain to be conveyed by the speakers, but it is seldom that such expectations and anticipations are realized to any greater extent than was true at the Cleveland Automotive Transportation Dinner held April 26, 1923, in the ballroom of the Hotel Winton and attended by more than 200 members and guests. President H. W. Alden was chairman; he stepped on the gas without hesitation and let the dinner

session into "high" with no clashing of gears by introducing George M. Graham, vice-president of the Chandler Motor Car Co., as one of the best worm-drive toastmasters in the Country.

In his introductory remarks, Mr. Graham spoke of the extent to which transportation had failed to develop until within the past 120 years, and emphasized that automotive engineers are pioneers in a great forward step for transportation, particularly in their attempts to correlate each factor of that transportation with all its other factors. He then introduced Alfred H. Swayne, vice-president of the General Motors Corporation, whose subject was "The Relation of the Automotive Industry to the Railroads," and who spoke, in part, as follows:

> The Chamber of Commerce of the United States invited the National Automobile Chamber of Commerce to send a committee . . . to meet a committee of railroad executives . . . Our committee discussed the question previously and outlined a policy which it would adopt if the discussion turned out to be in regard to the general attitude of the automotive industry toward the railroads. At that meeting Secretary of Commerce Herbert Hoover said that in the judgment of the administration railroad questions would be one of the chief issues in the next campaign and that unless something was done of a constructive nature to improve the transportation situation, we would drift into Government ownership of the railroads. He believed that this would not be for the best interests of the Country and that it was not what the Country wanted. He said that he had suggested this conference with a view toward seeing what could be done along constructive lines to improve conditions.
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> We then heard from the railroad executives representing 80 per cent of the mileage of the railroads in the United States. We listened to a lengthy discussion of the troubles of the railroads, of the difficulties of regulation and Government interference, and to the long history of legislation hostile to the railroads; but nothing of a constructive nature was brought out in going over a lot of old ground with which we were all more or less familiar, and we were told it was practically impossible for the railroads to get new capital under existing conditions . . .
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> When our turn came to discuss the matter, we told them very frankly we admitted all they said and recognized the importance of all their arguments, but that we were shippers and were vitally interested in getting transportation; that we had plants and dealers' organizations all over this Country; and that, without a steady flow of raw materials into our factories and finished product from them, we could not succeed in our business. We said we recognized that the railroads must expand their facilities to take care of our traffic, and realized that this could not be done without adequate capital. Also, that we knew they could not get that capital unless they had rates that would give a good return, and that this meant a return sufficiently attractive to induce new capital to enter the business to expand the railroads so as to take care of the Country's growth. We tried to make clear to them that we believed the interests of the automotive industry and those of the railroads lay along the line of cooperation and not opposition. . . .
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> We pointed out that we were one of the large customers of the railroads, that we should be good friends and that this would be to our mutual advantage if we worked together instead of against each other. We then said that we felt that a constructive program was necessary, and that we looked to the railroad men to develop this program. They knew the business and we did not; they had invested generations of experience in it, and they could hardly expect us to develop the remedy. The railroad representatives told us that, as shippers, we ought to take an interest in the problem. Our answer was: "What shall we do? We do take an interest. What do you want us to do of a constructive nature?"
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> We pointed out to them that one of the criticisms which seemed to be well founded was that they had the reputation of not being able to sink their differences and work together. We told them that if they would develop a program and the railroads and the automotive industry could agree upon it and would support it, that we would use our manufacturing and our dealers' organizations all over this Country to develop a sound public opinion, behind that program, and to endeavor to put it through Congress next winter. . . . Finally, Mr. Hoover said that he approved the attitude of our committee and thought that it was constructive. A resolution was proposed that the Chamber of Commerce of the United States appoint a committee which should make a thorough study of the transportation questions affecting the railroads, highways and waterways; and that on this committee should be represented the railroads, industry, agriculture and labor. That committee was appointed, and is now at work.
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> In the automotive industry, . . . we cannot succeed in our business and manufacture and distribute economically without the best of railroad transportation. . . . We can either pay for it in support of private ownership and give the railroads a chance to make reasonable returns on their capital, or we can let them drift into Government ownership, get poor service and pay for it in high taxes. . . . You will find that our interest lies in the support of private ownership of the railroads, in giving to them sufficient backing and help to develop a machine that can do our business economically and efficiently. . . . I am confident that the administration has three main points in view. First, to develop some railroad consolidations which it thinks will be in the interest of economy and efficiency. Second, to have a scientific revision of rates. . . . Third, the consolidation of the Railroad Labor Board and the Interstate Commerce Commission. It feels, and I think rightly so, that one body should be responsible for both income and outgo. . . .
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> Regarding railroad capital, it is a well understood principle of finance that certain relations must be maintained between junior securities and senior securities. By senior securities, I mean bonded debt and preference shares. . . . The proper proportions between the two must not be allowed to get out of line.
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> Since 1915 the railroads of this country have been unable to issue any common stock for capital purposes. It is evident that the railroads are spending money now for equipment and for expansion of various kinds, but they are simply mortgaging the surpluses that they built up before this state of affairs existed. They will come to the end of that before long. In the opinion of the best bankers, they have nearly reached the end now. Then the Country will find that it cannot get increased railroad transportation. The public will become impatient at that state of affairs and there will be only one credit available, that of the Government, and there will be pressure brought to bear to put the railroads into the hands of the Government, which I think would be greatly to our disadvantage. . . . When the Chamber of Commerce of the United States has developed this plan and introduces it to the public and to Congress, I hope automotive engineers will support it and do all within their power to develop a sound public opinion behind it. We should do this because it will be good business to do it; we should do this because it will be good citizenship.

The Automotive and the Railroad Interests

The need for the correlation of the automotive and the railroad interests was voiced in specific manner by W. J. L. Banham, general traffic manager of the Otis Elevator Co. and president of the Associated Traffic Clubs of America, the next speaker.

Stating that the lack of transportation is seriously impeding the production of the country and that, unless a condition can be created whereby it will be possible to move a substantially increased tonnage by the more intensive use of our present facilities, the present unsatisfactory situation will continue and the public will be required to pay high freight rates and receive unsatisfactory service in return, Mr. Banham reviewed present transportation impediments, inclusive of the congestion at railroad terminals and the restricted use of motor trucks, as a preface to discussing how these obstacles can be removed and how better coordination between the two transportation systems can be accomplished. To this end, an avoidance of long distance competition between motor trucks and railroads appears reasonable, and it seems that the activities of the motor truck should be confined largely to the movement of freight within the railroad-terminal area, or adjacent thereto.

To speed up the movement of freight passing through railroad terminals, it will be necessary for the carriers and the shippers to agree upon and develop a system of store-door delivery and collection service that would secure the more intensive use of the present terminals. What is needed at the present time is a much closer cooperation between the shippers and receivers of freight and the rail carriers than has existed hitherto.

In enlarging upon his subject, Mr. Banham discussed the prompt removal of freight from terminals, citing Canadian practice in some detail, and stated his belief that the motor truck and the highways should be used for the handling of short-haul freight covering distances up to 25 miles or distances to be agreed upon by the trucking and the railroad interests. Also, that motor trucks should serve as feeders for the railroads, acting as their agents and with their duties and responsibilities defined clearly by tariff regulations issued with the approval of the State and Federal Commissions.

The movement of less-than-carload freight between the carriers' sub-stations and main stations is also an important problem, and this was treated by Mr. Banham together with the so-called "trap-car" freight-service, believed by freight agents to delay less-than-carload freight seriously. He stated further that the proper understanding of the "field" of the various transportation agencies is vital, but in determining this field each form of transportation should bear its proper responsibilities and charges; no one class of carriers should be subsidized by the Federal Government or by the States to the disadvantage of other competing agencies; only by mutual understanding of the proper relationships can the good of the public as a whole be advanced; and that the encouragement of active and forced competition would, in the end, be destructive.

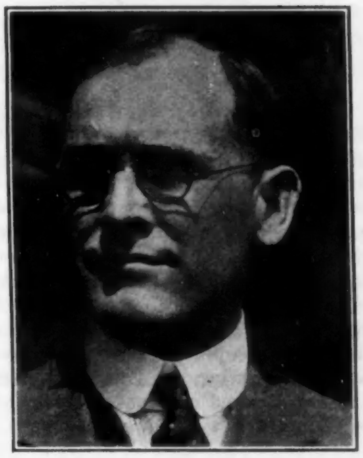
Present Status of the Railroads

The final address was made by Robert S. Binkerd, vice-chairman of the Committee on Public Relations of the Eastern Railroads, who recounted the efforts of railroad interests, since 1920, to find a sound harmonious transportation policy. He rehearsed the difficulties under which railroads have operated during this period, stating the big railroad problem to be whether the people of the United States will support a constructive policy toward the railroads that will permit them, as economic agents, to supply the facilities and service demanded for the welfare of the country.

Quoting statistics of development and the disadvantageous features of railroad operation under Federal control, the growth and improvement of service and equipment since private ownership again obtained were enlarged upon by Mr. Binkerd at some length. In conclusion, he stated that by Oct. 1, 1923, the railroads will be in better condition than before the war. They are aiming to increase the average loading of all freight cars to 30 tons and the average daily movement of all freight cars to 30 miles. By these higher levels of transportation, they expect to handle this year's great volume of traffic smoothly and efficiently. The railroads are forging ahead regardless of an income that is still inadequate and oblivious of political attacks, and are placing their reliance on the sense of fair play of the American people.

TRACTOR DEFECTS SUMMARIZED

Large Audience Hears Professor Sjogren's Report and Paper by C. M. Eason



The annual Tractor Meeting of the Society in Chicago on April 19 proved to be one of the most successful meetings ever staged in the farm power field. Over 100 representative tractor engineers and builders were in attendance; every one of the principal companies was represented, in some cases by three and four men. It was the consensus of opinion that the meeting had resulted in an excellent cooperative interchange of experience that would be of real value to all who attended.

Two technical sessions and a luncheon constituted the program. The morning session was addressed by Prof. O. W. Sjogren of the University of Nebraska. He presented an extremely valuable and informative paper that embodied an analysis of tractor-test data accumulated during 2 years of testing for the State at the University. Constructive criticism of tractor design, performance and serviceability formed one of the most interesting parts of the paper. The following paragraphs give some of the more important points brought out in the paper itself, and in the discussion that followed its presentation.

One of the outstanding discrepancies in the tractor field is the lack of an accepted standard method of rating, both in the belt and at the drawbar. In several cases, tractors of different makes using the same kind and size of engine have been given ratings of wide variation. Four tractors of different make equipped with identical engines are rated from 30 hp. at 900 r.p.m. to 35 hp. at 850 r.p.m., an increase of 16 per cent in the power rating with a 5½-per cent drop in the speed. In another case, the tractors are rated at 20 and 25 hp. respectively at exactly the same speed, a difference of 25 per cent. These cases indicate the existence of a condition that should be corrected. A standard method of rating, conscientiously observed, would provide a direct means of comparing tractor power. It would tend to instill greater confidence in the tractor industry on the part of prospective users. There should also be an accepted standard for belt speeds to avoid the present confusion. Wide limits may be desirable when a standard is first proposed, but it is time that one or two definite belt speeds be chosen and all machines equipped with pulleys to provide one of these speeds at its rated number of revolutions per minute.

Weight Distribution and Tractive Efficiency

One might assume that the very light tractors would have less weight per drawbar horsepower than the heavier ones. Professor Sjogren's data indicate, however, that the tractors having a total weight of about 4500 lb. have less weight per drawbar horsepower than either or the lighter or heavier ones. The general trend of the relation of total engine weight and engine weight per brake horsepower, indicates that the weight per horsepower increases as the total engine weight increases. Tractive efficiency seems to decline with an increase in the total weight beyond 4500 lb. With the wheel tractor, the tractive efficiency tends to become lower as the total weight per drawbar horsepower increases. Drive-wheel slippage decreases slightly as the total tractor weight increases.

A great variation was found in the amount of fuel required per horsepower-hour for the tractors tested in Nebraska. A variation was noted of 138 per cent, from the

lowest to the highest, on the belt test; and 181 per cent, from lowest to highest, on the drawbar test. The data reveal that the lowest fuel-consumption is secured with engines having cylinders between 5 and 6 in. in diameter. Engines of the valve-in-head type gave better fuel economy than the L-head type on all operating loads. It was notable that the fuel required on drawbar work was almost double that required on belt work.

Defects in Tractors Tested

Professor Sjogren summarized the principal defects that had been encountered in the Nebraska tests for the purpose of offering constructive criticism leading to the production of better tractors. It was necessary to adjust push-rods on a considerable number of the engines before the tractors could be tested. In many of these cases the power output was increased. There were frequent instances where the valves were not fitted properly at the factory. Belt pulleys of the attachment type gave considerable trouble, probably due to their having a short shaft with only one bearing. Lack of proper clearance between pulley and drive wheel was encountered. This is especially undesirable when the tractor is used on wet ground, the soil filling in on the drive wheel until it rubs against the belt pulley and stalls the engine. Some tractors would not allow the engine to be cranked with the belt on; this is a very bad arrangement. Most of the difficulty with cooling systems seemed to be with the fan and its drive. In twenty-one cases the fan-belt was the offender. Clutches had to be adjusted in many cases. In a few instances the carbureter was replaced with one of different size or make and the power and operation materially improved as a result. There were cases where the power output was increased materially by removing the air-cleaner, indicating that the cleaner was too small. Air-cleaners using water should be designed so that the water supply can be replenished while the engine is under load. This is particularly important when working on the belt.

Many tractors were submitted for test equipped with governors that were practically useless. The governor should maintain speed within 5 per cent either way; there were examples where a variation of 50 per cent in the speed was possible. The most frequent difficulty encountered in the ignition system was errors in timing. Difficulty with the chassis was met only in limited degree; there were some instances of improper lubrication, poor steering-gears, and weak construction evidenced by broken bolts, twisted frames and broken gears.

Suggestions for Improved Design

More attention should be given to the comfort of the driver. He should be seated so that he has a good view of the field ahead of him. The seat should be located so that he will not be directly in the path of the hot air blast from the fan, nor in a position close to exhaust pipes or other heated units. Accessibility should be carried to the utmost degree of convenience for inspection, adjustment and repair. Professor Sjogren made three specific recommendations.

(1) More rigid inspection of parts as well as the finished machine
(2) More rigid tryouts in the field under various conditions before the tractor is finally approved for production
(3) A choice of accessories based on a thorough study of them as related to the particular machine in question

Professor Sjogren's paper was followed by a very active discussion. A. W. Scarratt urged the adoption of some standard method of rating, remarking that differences in transmission did not warrant the extravagant claims made by some companies who used stock engines that were given a lower rating by other and more conservative firms. H. A. Huebotter of Purdue University agreed with Mr. Scarratt, saying that not over 30 per cent of the tractor engines are rated lower than 80 per cent of their maximum belt horsepower. He asked Professor Sjogren what field condition was represented in the test-track soil at the University of Nebraska. Professor Sjogren replied that it was difficult to say. The so-called cinder track was, in reality, only covered with a thin bed of cinders to improve drainage conditions and arrive at a more nearly uniform condition of the soil for testing purposes. He would judge it to approximate a plowed field of medium hardness with fairly compact bottom soil, stubble ground rather than covered with sod.

R. F. Vogt, of the Allis-Chalmers Mfg. Co., read a prepared discussion in which he claimed that the Nebraska test practice of measuring wheel revolutions on only one rear wheel brought an appreciable error into all of the performance calculations, particularly those involving wheel slippage. He submitted examples calculated from Nebraska test data to show that a reasonable difference in the number of revolutions between the two rear wheels would result in the drawing of erroneous conclusions if the revolutions of only one wheel were considered. Professor Sjogren stated that he was convinced that there could not be any great difference between the speed of the two wheels under the test conditions. He had checked this matter closely with electric tachometers that are now a part of the regular test equipment, and the variation was never found to exceed 5 per cent in the extreme cases. Slippage data are now given in the test reports in two ways to avoid a criticism that has been voiced in the past; one column gives the figures based on the diameter of the drive wheel measured at the outer point of the driving lugs; a second column includes these same data based on a diameter taken at the rim of the drive wheels.

Asked regarding fuel consumption, Professor Sjogren said that the tractors burning kerosene used from 0.63 to 1.40 lb. per b. hp-hr. Those using gasoline burned from 0.65 to 1.13 lb. per b. hp-hr. He had not tested any steam or heavy-oil burning tractors but was in a position to test the latter type. There has been a noticeable improvement in the cooling systems of most of the tractors tested in the last year over the earlier models, very few cases of over-heating being observed. C. M. Eason remarked that the matter of wheel slippage was one of the most troublesome problems before the tractor engineer and gave some of his personal experiences in trying to measure it accurately.

General-Purpose Tractors

C. M. Eason gave an interesting talk on the general-purpose type of tractor at the afternoon session, abstracting his paper which, it is expected, will be printed in an early issue of THE JOURNAL. He had gathered a very comprehensive set of photographs illustrating a large number of experimental machines designed to displace completely the horse on the farm. These were shown to the members in slide form and each type discussed by the speaker. O. B. Zimmerman read a short contribution in which he outlined some of the development work done on the general-purpose tractor by the International Harvester Co. A. W. Scarratt believed that the all-purpose machine should be built of a size and power to handle two plows. Dent Parrett called attention to the importance of building greater durability into the general-purpose tractor because of the increased number of hours it would be operated. Prof. J. B. Davidson, of the University of Iowa, was of the opinion that corn cultivation formed the most important problem to be solved in any general-purpose tractor since corn acreage forms the major part of the average American farm. Good directional control is essential in corn cultivation; Professor Davidson did not believe line or rope control would prove satisfactory. He favored using

H. O. K. Meister Prof. J. B. Davidson A. W. Scarratt O. B. Zimmerman R. F. Vogt
SOME OF THE MEN WHO WERE RESPONSIBLE FOR THE SUCCESS OF THE TRACTOR MEETING

only two plows with the general-purpose tractor, but recommended that it be arranged to cultivate four rows at a time. O. B. Zimmerman characterized the later types of tractor as the spider type because of their peculiar appearance when built to straddle and be clear of the rows of growing corn.

C. C. Trump did not agree with Mr. Eason when he stated that the production of steam propelled tractors would not show an increase in the future. He remarked that considerable progress had been made in the more efficient design of boilers, fireboxes and engines so that higher efficiencies were now attainable. The steam tractor will burn wood, straw, oil or coal; it can furnish heat, light and power in the winter season. Several firms are now studying the possibility of building steam-propelled tractors of a lighter type than those now in use, taking advantage of all the latest progress made in combustion and steam engineering.

In closing this account of the 1923 Tractor Meeting, acknowledgment is made of the extremely valuable work of H. O. K. Meister, who was responsible for the excellent group of talks and the other meeting arrangements. Appreciation is recorded also of the fine cooperation of the Farm Equipment Manufacturers' Association in arranging the annual meeting of their Tractor Division on the day following the Society meeting, thus increasing the attractiveness of both meetings and resulting in the large and representative attendance.

FARMERS NEED EFFICIENT TRACTORS

American Farm Bureau Federation's President Gives Tractor Engineers Good Advice

The ultimate type of farm tractor that is suited to the needs of the average American farmer has yet to be developed. This is the opinion of O. E. Bradfute, president of the American Farm Bureau Federation, who addressed the Tractor Luncheon in Chicago on April 19. His address, which was given from the farmer's viewpoint, was received enthusiastically by an audience of ninety members and their guests.

Mr. Bradfute believed that the American farmer is more efficient than the farmers of any other country, when he is judged comparatively by the average acreage that is worked by the farmers in each of the great agricultural nations. Since this efficiency is dependent upon his possession of efficient farm machinery, he is always interested in every advance made in the further application of mechanical power to the work of the farm. The cost per acre of producing grain in 1847 was less than it is today in spite of the use of our highly developed farm implements; this is true whether the cost is figured in dollars or in wheat. The increased cost of labor and farm implements apparently has offset the improvement in farm efficiency and the ultimate costs are not reduced. Thus we see that further engineering advancement is important.

It required a number of years to develop a stabilized and universally accepted design of automobile; this will probably be the case with the tractor. Not only is the type to be determined, but there is no agreement at present on the size best suited to the needs of the average farmer. Mr. Bradfute made a plea for the utmost simplicity in any mechanical equipment that is intended to give service in the hands of the farmer. Adjustments must be easy to make and to understand; there must be a higher degree of accessibility than has been evident in the tractors of the past. Standardization must be applied to the simpler parts such as the nuts, bolts, threads, etc., so that the farmer does not need two or three sets of wrenches to adjust his implements, even though they are the product of several different manufacturers.

P. E. Bradfute Finley P. Mount
TWO OF THE SPEAKERS AT THE TRACTOR LUNCHEON

The ultimate type of tractor must be reasonably inexpensive in first cost because the farmer is not in a position to finance the purchase of expensive equipment. It must be made of the general-purpose type so that it can be used for a longer period of time and completely displace the horses on the farm. Mr. Bradfute said that he was unable to use the tractors on his own farm for a longer period than fifty days of each year. The possibility of a fuel shortage must not be neglected in any discussion of the future farm tractor. The farmer is constantly thinking of the possibility of using the waste products of the farm in producing alcohol for power and heating purposes. He is hopeful that electricity will be used eventually as a means of driving farm tools and hauling his farm implements, for this would enable him to make use of waterpower that is available on many farms and is now being wasted.

The purchasing power of the farmer is a matter of concern to all business men; the present tendency of higher prices in labor and machinery is not being accompanied by a relative increase in the prices of farm products; this is resulting in a limitation of the farmer's ability to buy manufactured goods. We are staring that situation in the face today and the prosperity of the implement and vehicle industry will be adversely affected unless this condition is remedied.

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ACROSS THE SAHARA DESERT BY MOTOR CAR

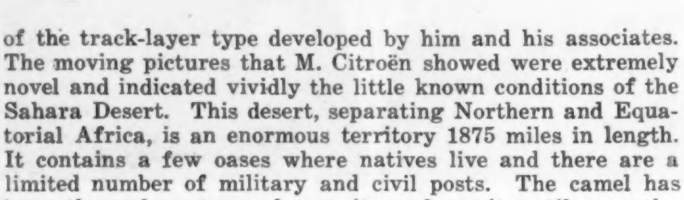
André Citroën Received Enthusiastically at Sessions in New York City and Detroit

A special meeting of the Society was held last month in New York City at which M. André Citroën, a member of the Society resident in Paris, France, who is well known as a gear and car maker, gave very interesting and instructive talks on the crossing of the Sahara Desert by automobiles

André Citroën

of the track-layer type developed by him and his associates. The moving pictures that M. Citroën showed were extremely novel and indicated vividly the little known conditions of the Sahara Desert. This desert, separating Northern and Equatorial Africa, is an enormous territory 1875 miles in length. It contains a few oases where natives live and there are a limited number of military and civil posts. The camel has been the only means of transit used on it until recently, this means of transit taking M. Citroën said more than a year to traverse the desert.

The speaker pointed out that the soil of the desert is the automobile's most deadly enemy; the sand raised by storms



A Contrast in Methods of Transportation in the Sahara Desert

is liable to get into and clog the engine. In fact, inasmuch as the soil cannot be adapted to vehicles of the conventional type, vehicles must be adapted to the soil. A type of car capable of traveling safely across sand and pointed rocks, using as little gasoline and as few tires as possible and yet capable of carrying the necessary load, had to be constructed.

In 1921 there were constructed in M. Citroën's factory some cars fitted with apparatus designed by M. Kégresse, a French engineer, who was formerly head of the automobile service of the Czar of Russia. This apparatus consisted essentially of introducing between the soil and the friction rollers carrying the chassis a continuous band of reinforced rubber. The front wheels of the vehicle, which are of the ordinary type, carry relatively very little of the load.

In the first expedition to the Sahara there were five 10-hp. cars carrying two men each. In this the journey from Touggourt to Timbuctoo and return, 3750 miles, was made in 34 "marches" taking 44 days. The second expedition, under the command of M. Citroën, consisted of three light cars carrying six people. It covered 1563 miles of the journey from Touggourt to Tadjemount and return in 10 "marches" taking 16 days. Extra supplies of gasoline were, of course, carried on the cars of the expedition, there being supply posts from 600 to 800 miles apart. Room could not be spared on the cars for the carrying of wireless apparatus. The conditions encountered ranged from the burning sand to icy cold nights. Lighter and faster cars were used in the second expedition, these being able to run at twice the speed of those in the first expedition.

In closing, M. Citroën said that, distance existing only because of the time it takes to compass it, the distances across the Sahara have been reduced in the proportion of 30 to 1, the 1875 miles from Touggourt to Timbuctoo in a track-laying automobile being equivalent to about 60 miles on a camel's back. When routes are mapped out and supply service assured, nothing will prevent comfortable traveling in the desert, the magic and majesty of whose sandy plains extend as far as the horizon, changing in color tone at each hour of the day. The track-laying automobile covered 156 miles per day at the rate of nearly 19 m.p.h.

André Citroën addressed an audience of over 1000 people at the meeting of the Detroit Section of the Society on the evening of April 16 in the auditorium of the General Motors Building. His talk was accompanied by motion pictures of the Trans-Sahara expedition undertaken by a caravan of Citroën-Kégresse track-driven cars. M. Citroën predicted that there would be an increasing interest in the small car in the United States because of the economy of operation and greater ease of handling of the smaller and lighter vehicles. He expressed the opinion that the public would appreciate short wheelbase, narrow tread and short turning radius because of the serious traffic congestion on the streets of our larger cities. Gasoline mileages of these smaller vehicles reaches the 40 figure and tire mileages are materially raised also. It is possible to build these smaller cars so that they seat four persons comfortably, yet do not exceed 1800 lb. in weight complete with body. M. Citroën exhibited a taxicab in Detroit that had a narrow tread and seated two people in the rear compartment; he pointed out that taxicabs seldom carry more than two passengers and he believed that the small light car was ideal for this class of service.

LUBRICATION AN EDUCATIONAL PROBLEM

At the New England Section's meeting on April 26, G. A. Round of the Vacuum Oil Co., New York City, discussed lubrication as a problem in the education of the car operator and owner. Mr. Round pointed out the importance of lubrication and showed that a large percentage of lubrication difficulties which reflect alike on car builder, fuel refiner and lubricant manufacturer, could be prevented by the operator, if he were educated along the right lines. The weaknesses of the usual oil recommendations were cited as examples of what should be avoided. Suggestions were also made for the

education of the car-owner to minimize the dilution, carbon, water and sludge-accumulation evils.

Mr. Round presented some very interesting data on the formation of emulsions and the effect of dilution on the lubricant. He also showed photographs from recent tests, proving that some cases of difficult starting in cold weather are due to the freezing of accumulated moisture in the combustion-chamber. In conclusion, Mr. Round described changes in design that would minimize lubrication difficulties and aid in their control.

Two features are scheduled for the next meeting of the New England Section on May 10 at the Hotel Kimball, Springfield, Mass., beginning at 8 o'clock, following a dinner at 6.30 p. m. R. E. Northway, president of the Northway Motors Corporation, will speak on Types of Automobile Spring-Suspension and Materials for Springs. The Department of Commerce film on alloy steel will be shown, to illustrate Mr. Northway's talk.

ELECTRIC TRUCK ADVANTAGES CITED

Engineer Believes Them Superior to Gasoline Vehicles for City Delivery

Claiming that it costs 70 per cent more to haul urban freight by gasoline-propelled trucks than by electric trucks, J. G. Carroll introduced an active discussion of the motor-transport subject at the meeting of the Mid-West Section on April 20. Mr. Carroll, who is chief engineer of the Walker Vehicle Co., read a well-prepared paper on the General Design of Electric Street Trucks and Their Performance in Urban Work. Descriptions were given of the various types of chassis, motor mountings, batteries, controllers and the methods of final drive that are in general use in the electric vehicle as constructed today.

The electric truck is capable of operating 40 to 50 miles on a single charge of the battery. A large department store reports an average daily mileage of 30; the American Railway Express Co. reports an average of 20 miles daily for its electric trucks. It seems safe to assume that a single charge of the battery assures an ample delivery radius for practically any city route. Operating speeds of electric trucks range from 10 m.p.h. for a 5-ton truck to 18 m.p.h. for a ½-ton truck. The gasoline truck has the advantage over the electric truck on the straightaway, but in multi-stop service the disparity disappears and the electric truck is superior because of its ability to accelerate very quickly.

A distinctive advantage of the electric truck is that all of its moving parts are at rest when the truck makes a stop. On the average 30-mile city route and in 8 hr. time, the trucks are in motion only 2½ to 3½ hr., yet the engine of the gasoline truck will be turning over almost continuously through the entire 8-hr. period. The salient characteristics that contribute to the advantages claimed for electric trucks over those propelled by gasoline engines were enumerated as follows by Mr. Carroll:

(1) Substantial construction and elimination of the reciprocating internal-combustion unit practically eliminates road troubles, reduces maintenance expense to a minimum and obviates the need of highly paid mechanics

(2) Minimum vibration, freedom from adjustments and prevention of careless speeding, prolong useful life of the truck

(3) Reliability and uniform driving power throughout the life of the motor which is designed to deliver maximum power to the driving wheels as required

(4) Operation at safe economical speeds due to the inherent characteristics of the series motor, the speed of which decreases automatically with an increase in the load

Robert E. Wilson was elected chairman of the Mid-West Section at the April meeting. Many of the members are familiar with the valuable research work done by Professor Wilson in the study of fuel volatility, crankcase-oil dilution and the theory of lubrication, the results having been presented at past meetings of the Society. Other officers elected were: Taliaferro Milton, vice-chairman; W. J. Buettner, treasurer, and H. O. K. Meister, secretary.

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THE ESSEX AND SUSSEX HOTEL, SPRING LAKE, N. J.

SUMMER MEETING NEXT MONTH

Spring Lake, N. J., An Attractive Resort That Will Appeal to All

The approach of warmer weather and the summer season reminds us that the popular Summer Meeting of the Society will soon be here. One of the attractive hotels that will house the members at this important medley of business and pleasure is illustrated on this page. Hotel facilities will be found equal to those at any previous summer gathering; there will be ample room for everybody and the service and meals are recommended to us as being of the first order. There has been a strong demand from some quarters for the choice of a seashore resort as a meeting location; Spring Lake will surely appeal to this class. The growing popularity

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GOLF AT SPRING LAKE

of the recreational part of the program necessitated the selection of a location where adequate sport facilities could be had. Spring Lake boasts of two 18-hole golf courses, both well kept and sporty enough to try the skill of those who claim to be graduates of the dub class. There is a fine group of tennis courts for the racket wielders and a still water pool will tempt the more talented exemplars of the Australian crawl.

Plans for the professional meetings are not sufficiently advanced to enable an announcement to be made, but the papers and speakers will be equally as valuable as those presented at other Summer Meetings. Topics will be selected for their general interest and urgency. Further progress on the Society's fuel investigations at the Bureau of Standards will be reported. The matter of crankcase-oil dilution will receive attention. The Standards Committee will hold its semi-annual meeting and vote on new and revised standards that are of vital importance to the industry.

The railroads have offered half-fare return concessions to the members who will journey to the Summer Meeting from nearly all of the automotive territory. It has been possible to prepare a schedule for a special all-Pullman train from the Middle West direct to Spring Lake over the Pennsylvania Railroad. This train will be made up of sleepers from Detroit, Cleveland, Chicago, Dayton, Toledo, Indianapolis, St. Louis and intermediate points. They will all be brought together at Pittsburgh and run from there as a single Society of Automotive Engineers train.

Spring Lake can be reached by paved roads from either New York City or Philadelphia. Garage facilities are provided so that members' cars can be properly stored and taken care of during the meeting period. One of the companies in the industry has prepared a special road map that will be mailed to all of the members some time during the month of May.

Application blanks for reservations, schedule of rates, railroad information and all particulars will reach the entire membership with a special issue of the *Meetings Bulletin* about May 5.

CLEVELAND PAINT MEETING

Double Program on Paint Making and the Sales Appeal of Color

After the inspection trip through the Sherwin-Williams Co.'s Cleveland plant on the afternoon of April 10, J. O. Hasson, director of the company's chemical and technical production sales department, addressed a group of Cleveland Section and Cleveland Engineering Society members in the club room of the Sherwin-Williams plant.

Mr. Hasson compared the scientific making of paint to an engineering problem with its many details demanding for solution a complex organization covering the entire world. The Sherwin-Williams organization includes a testing department for raw materials, chemists, formulators and testers, both technical and practical, for the finished product. Raw materials are tested and analyzed before they are turned over to the formulating department where experienced formulators, working on the reports of the testing department and the chemists' analyses, compose the formulas on which the manufacturing department works. Every known surface, metal, wood, paper or what not, is considered as an individual problem, for which a separate formula must be made. The finished product is thoroughly tested as to drying, covering, flowing and color. After these technical tests, the paint or varnish is tried out under the conditions it would meet in actual use.

The problems of the car builder and the demands he makes on paint have changed with the speeding-up of production and the introduction of metal bodies. The paint and varnish manufacturer who maintains a complete and active research department can prescribe the right finish and method of application for a given use, but he is often hampered by competitive price conditions. Mr. Hasson summed up the unique service of the Sherwin-Williams Co. as that of an automotive finish clinic to handle all the ailments of the automotive industry and all other industries that use technical paints and varnishes, a service that is extended even to the consumer of a product with a Sherwin-Williams finish.

After the usual informal Section dinner, the evening session of the Paint Meeting opened at 8 o'clock in the Hotel Winton. Illness prevented the appearance of Edward S. Jordan, president of the Jordan Motor Car Co., who had been scheduled to speak on The Psychology of Paint in the Appeal of the Motor Car. The Section was fortunate in being able to secure Edward Patton of the Franklin Automobile Co. to speak on the same subject.

Mr. Patton reminded his audience that a man will always buy on the appeal to his emotions when he will not buy on the appeal to his will or his mind. It is the emotional appeal every time that will get the sale. The first step in the selling process is to attract attention. That is where perhaps the coloring and painting of cars is an aid, though the car that will attract the most attention is not necessarily the most desirable. In the long run, a thing must have utility value to succeed. The attention value of color has been vividly brought out by the Red Top Taxicab Co. in Cleveland and by the Checker and the Yellow Cab companies all over the country. Color is the thing that keeps them continually before the public. Direct-by-mail advertising has proved that 15 times as many replies can be brought in by the use of color. It is, of course, unlikely that 15 times as many cars could be sold by changing the color, but there is a chance to put certain colors in certain communities. Mr. Patton illustrated his point by citing some of his own selling experiences. A green car would sell in the lumber camp communities of northern New York, but there was no market for a dark blue car. In the towns made up of wealthy conservatives, the standard dark blue was the only choice. There was one exception in Auburn, N. Y., a green car with red wire wheels caught the fancy of an Italian bootlegger. As a rule, towns of from 30,000 to 40,000 insisted on standard colors; but in the smaller towns and the mountain country, the brighter and cruder the colors, the bigger the sales.

Color has been found to have suggestion values. It tells a story and should, therefore, be suited to the product. You would laugh at a Ford painted a bright red, but you would not laugh at a Stutz in the same color. The big maroon sedan has an air of luxury and a dark blue car has a certain air of aristocratic aloofness. Dark green is always restful, but a vivid green is repellant. A wealthy car owner in central New York was obliged to take a $6,000 depreciation on a vivid green car only six months after he bought it. Brown makes a car look heavy whether it is or not. Black is so widely used in the automobile business probably only for its high utility value. It is not attractive in itself and is almost wholly negative in suggestion.

In conclusion, Mr. Patton emphasized the selling value of appearance. If a car has good lines and a bright color, if it is one the buyer will take pleasure in owning and driving and letting people see, its appearance is the biggest factor in the sale.

The next session of the Cleveland Section, on May 18, will be a business meeting at 8 o'clock, followed by an entertainment, after the usual get-together dinner at the Hotel Winton at 6:30 p. m.

ENGINEERING BRAINS IN FLEET OPERATION

Valuable Discussion at Metropolitan Section Meeting Between Fleet Operators

At the April meeting of the Metropolitan Section, E. E. La Schum, general superintendent of motor-vehicle equipment of the American Railway Express Co., gave a very interesting address on the need of engineering skill in truck fleet operation. J. F. Winchester, supervisor of motor equipment of the Standard Oil Co. of New Jersey, in the comprehensive discussion he presented said that the industry is on the verge of important developments tending toward more

Schedule of Sections Meetings

MAY

1—DAYTON SECTION—Fundamental Principles of the Design of Military Airplanes—W. F. Gerhardt

2—MINNEAPOLIS SECTION—Some Experiences in First Breaking Peat Land—J. L. Larson; Electricity in the Motor Vehicle—North East Electric Co. film

3—INDIANA SECTION—Engineering Information from the Race Track—F. S. Duesenberg

4—WASHINGTON SECTION—Highways and Traffic—Major F. S. Besson

10—NEW ENGLAND SECTION—Types of Automobile Spring-Suspension and Materials for Springs—R. E. Northway; The Story of Alloy-Steel—Department of Commerce film

17—DETROIT SECTION—Four-Wheel Brakes—M. Lougheed

17—METROPOLITAN SECTION—Steel—Dr. J. A. Mathews; Non-Ferrous Metals—C. H. Landon; The Story of Alloy-Steel—Department of Commerce film

18—CLEVELAND SECTION—Business Meeting

economical operation of motor vehicles. F. C. Horner, of the General Motors Corporation, took a leading part in the discussion, asking among other things what is the best way to decide upon what vehicles to standardize.

Mr. La Schum said that during 1922 the American Railway Express Co. handled more than 184,000,000 shipments, the average weight per shipment being about 82 lb. The gross revenue was $294,000,000. The automotive equipment of the company in the United States and Canada is constituted of over 2600 gasoline vehicles, about 1200 electric trucks of the conventional type and over 300 industrial trucks, together with 100 semi-trailers. While only one-third of the vehicles owned by the company are self-propelled, they have a capacity of over 50 per cent of the total load hauled. The horse-drawn vehicles average 12 miles per day; the electric vehicle 20 miles per day; and the gasoline vehicle 30 miles per day.

The speaker stressed his belief that in connection with all important features of motor-truck equipment and operation, careful analysis should be made by competent engineers. He said that his company does not encounter the breaking of frames now in its regular service, but that this fact is attributable to proper supervision, inspection and stitch-in-time methods, keeping rivets tight, wearing parts properly lubricated and natural wear corrected. The same sort of thing applies to many other truck units.

Mr. La Schum said that, while there should be an improvement by way of the development and the standardization of such equipment as odometers and radiator guards, and of greater accessibility of gasoline filling openings, the records of reliability of modern motor vehicles are excellent. With regard to maintenance costs, the following percentage figures were presented, not including drivers' wages, depreciation, interest and insurance:

Gasoline	30.00
Cylinder Oil	2.25
Tire Costs	2.50
Painting	1.30
Body Repairs	4.75
Chassis Repairs	35.20
Garage Expenses	24.00
	100.00

The speaker advocated the use of non-adjustable carbureters when feasible and teaching the drivers that a rich mixture, which may make possible the negotiation of a given grade without shifting gears, results in a 35-per cent excess of fuel consumption, and increases carbonization.

In speaking of the operation of over 800 gasoline trucks in Atlanta, Buffalo, Chicago, Cleveland, Detroit, New York City, San Francisco and the City of Washington, Mr. La Schum stated that in 1922 these trucks worked 306,348 days of 8 hr., their total mileage being estimated to be 9,190,000 miles. During that year there were only 6200 emergency calls for help for these trucks. The causes of these calls are shown in the following percentage figures:

Engine Bearings	0.8
Spark-Plugs	5.9
Ignition System	9.1
Carbureter	8.6
Gasoline Lines Clogged or Leaked	7.6
Broken Fans or Fan-Belts	9.3
Radiators	1.1
Water-Pump or Line	1.6
Radiators or Pumps Frozen	0.2
Governors	0.5
Steering Gears	3.3
Clutch	3.0
Propeller Shaft	1.5
Universal Joints	1.1
Transmissions	3.0
Differentials	0.5
Rear Axles	0.9
Radius Rods	0.9
Drive Chains	3.8
Wheels	1.5
Springs	1.8
Brakes	2.2
Tires	3.3
Lights	1.0
Accidents	1.6
Out of Gasoline or Oil	3.1
Miscellaneous	23.8
Total	100.0

In other words, there were only 50 cases of bearing trouble, and rarely a case of a full set of connecting-rod bearings burning-out.

The spark-plug trouble was due almost without exception to drivers using a choker and fouling the plugs by too rich a mixture. The spark-plug replacement has been less than one-half of one spark-plug per truck per month. In the above table "ignition system" does not include spark-plugs.

During last year, 226,716 working days were obtained in the same cities as those named above from 722 electric trucks. There were less than two emergency calls per truck, the total mileage being 4,870,752. Approximately 91 electric motors burned-out, due in many cases to overloading. There were 366 cases of exhausted batteries; that is, a battery was exhausted once per truck per two years. Controllers caused 12.1 per cent of the troubles; steering-gears, 6.2 per cent; axles, 1.5 per cent; brakes, 5.0 per cent; springs, 1.3 per cent; drive chains, 11.6 per cent. Mr. La Schum said that chain troubles have been eliminated in modern electric-truck operation.

Mr. Winchester argued that a standardized form of cost analysis is needed to enable different operators to compare their results, certain standardized forms of bookkeeping that have been used being too complicated. He asked whether the direct comparison of mechanical operation costs should be based on the average cost from data of installation by individual truck; by fleet operation, that is, by make and model; or by a division of the cost by year of installation. He expressed the opinion that simplicity should be the keynote.

The speaker did not concur with Mr. La Schum's conclusion that first consideration should be given to the organization of maintenance and not that of operation. Mr. Winchester said that the operation organization is burdened with the reduction of items of expense developing fixed charges, these apparently constituting 65 per cent of the total operating charge. The maintenance organization controls the items of variable cost; these being largely mechanical expenses, and in Mr. Winchester's opinion amounting to about 35 per cent of the total. Whatever unit cost is taken as a base, careful routing and planning are the greatest factors in reducing expense. The efficiency of trucks from the standpoint of variable charges, such as those for gasoline, lubricating oil and grease, depends largely upon vehicle design and generally speaking no great economies can be effected in this connection in individual models. The organization of maintenance should render the organization of operation efficient engineering and general service so that the unit cost may be duly minimized.

Mr. Winchester was of the opinion that the selection of an engineer to manage a fleet of vehicles should not involve duplication of experimental engineering work done at the various vehicle factories or elsewhere, but that all available engineering data should be availed of in fleet operation.

He urged that a mechanical-installation sheet be prepared along standardized lines to furnish the truck operator with complete mechanical specifications of the type of installation in which he is interested. Such a sheet should provide for the recording by the manufacturers of structural changes in trucks to assist the operator in ordering material for a given truck. Items mentioned by Mr. Winchester were cylinder oversizes and gear-ratio changes. In his opinion the catalogs supplied in the past do not meet the present condition. If fleets are to be operated efficiently it will be necessary to have these details, the general information contained in the parts lists being inadequate. Mr. Winchester suggested also that the truck industry do more in the way of supplying fleet operators with complete engineering data on fits for the assembling of such parts as pistons and bearings. This would be particularly helpful in overhaul work. This, in conjunction with the need of a fleet basis of repair rates, is in Mr. Winchester's opinion a crying need, particularly in connection with the work of small fleet operators.

With regard to tire equipment, Mr. Winchester said:

> My experience definitely proves that the type of tire employed has a definite relation to the efficient operation of the truck itself. We as an industry have heard certain claims made by the tire manufacturers for different types of solid, pneumatic and cushion tires, and also by wheel manufacturers on the subject of reducing operating cost. I believe that this is the most vital problem in considering tire installation. I feel sorry for the operator who paid considerable attention to the various claims made for pneumatic tires in the last few years for trucks of 3½-ton capacity and over. I also believe that certain types of tire for the lighter equipment can be employed to advantage. Why should we consider tire cost only in view of the differences in repair and mechanical-upkeep cost on various types of tire that indicate a large saving can be made? To illustrate this point I give the following:

Type	1	2
Time in Operation, months	27	25
Total Tire-Cost per Mile	\$0.0273	\$0.0167
Total Repair-Cost per Mile	0.1043	0.0729
Total Mechanical Cost per Mile	0.1759	0.1317

> Based on this difference in cost, presuming that 100 trucks ran 25 days per month, 12 months per year and 35 miles per day, we have a total mileage of 1,000,050 miles per year. The difference in the mechanical-repair cost in this case represents a saving of \$33,600 per year, while the difference in the total mechanical cost represents a saving of \$46,200 per year. These figures indicate why we should keep tire records.

Mr. Winchester made a plea also for the formulation of a standard form of distribution of chassis overhaul cost. He said that his experience indicated that a 5-ton engine after running from 18,000 to 24,000 miles should be overhauled in a labor-hour classification of not over 90 hr.; while the total repair cost including all charges should not exceed \$900 average. In commenting upon the analysis of troubles given in Mr. La Schum's paper, Mr. Winchester said that results vary with the types of vehicle used. Road conditions and the average age of the fleet make a big difference in percentages. He said that he seldom hears of troubles relating to spark-plugs, carbureters, gasoline lines clogged or leaking, governors, propeller-shafts, universal-joints, radius-rods, drive-chains, wheels, brakes, oil shortage or tires; this condition being due largely to systematic inspection. The adoption of a strainer-funnel of proper design eliminates for the most part clogging of gasoline lines. The spark-plug consumption of the motor-truck fleet that Mr. Winchester supervises has been approximately one spark-plug per cylinder per year. The design of the oiling system plays an important part in this connection.

Mr. Winchester expressed the opinion that a fleet which operates over an extended area and does not come into a central garage each night, but is left to the care of the individual operator except for a bi-weekly inspection, can be operated very efficiently with a reserve equipment of 1 truck in 16; with efficient central control and a systematic method of upkeep this quantity of reserve equipment can be very materially reduced.

Mr. La Schum said that a 2-ton electric truck in proper condition with varying loads, will make regularly 30 to 35 miles per day on a single charge.

THE SERVICE-MAN AND THE CAR-OWNER

Relations Between Them the Chief Topic at Minneapolis Section Meeting

The relation of the service-man to the car-owner who makes use of his service, was the principal topic at the meeting of the Minneapolis Section, held on April 4, at the Manufacturers' Club.

C. M. Stroud of the Oakland Service Co. ranks an even disposition as one important qualification of a good service-man. So many car-owners feel it their duty to abuse the service-man, not realizing that the service organization could not exist if it did not adequately serve the car-owner. Service-men are human, and the man who gets real service is not the man who insists that his work be rushed through before everything else, but the man who drives in and in a pleasant way says, "Well, boys, the old car is not running as it should today. Try her out, fix up the trouble, and call me when the car is ready."

Unfortunately, the repair business has a reputation for building up repair bills and giving little in return. This charge is founded on a misunderstanding of the situation. Few car-owners know enough about a car to figure the cost of labor and parts needed for repairs. As a rule, a car gets very little attention unless it breaks down. Nearly every company that sells cars invites the owner to bring in his car for examination at least once a month, but very few take advantage of this offer. Regular inspection and making repairs as needed would save many dollars in repair bills and cars so maintained would give better service.

In discussing what should be expected of a service-station, Mr. Stroud emphasized the sales value of satisfaction. Satisfied owners are the best salesmen and good service is the

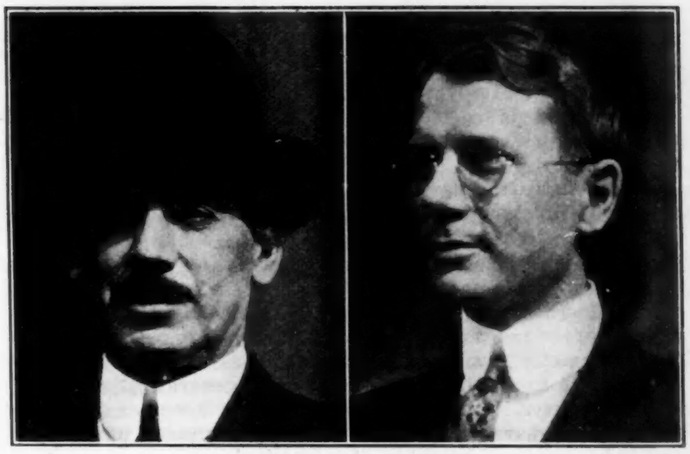
one thing that makes a car-owner brag about his car. Give a man all he can reasonably expect when he brings his car in for repairs and he will keep coming whenever he is in need of repairs. If the selling company would only make an effort to have the service department the talk of the town, they could hold their car-owners and the small garage men would not have much to do. The modern service-station is equipped with up-to-date tools for quick repairs and mechanics who know the car. The old type of "Greasy Bill" mechanic is being replaced by the mechanic who takes pride in his work.

Mr. Stroud pictured the ideal service-station as big enough to accommodate a large number of cars on the ground floor without crowding, so that cars could be driven in and out without damage. There will be no guessing school connected with the establishment. Inspectors will examine a car, tell the owner what is needed, how much it will cost, and when the car will be ready. While specialists in ignition, carburetion, etc., make the necessary repairs, the owners will be able to wait comfortably in attractive waiting rooms provided especially for their convenience. Mr. Stroud's paper was followed by a discussion from several angles of the details of service-station management, including the use of the so-called flat-rate charge for making repairs of all kinds to different classes of automotive vehicle.

The second paper, Advantages to the Twin Cities of the Ford Factory Project, was given by R. E. Hilton, secretary of the St. Paul Association, in place of Col. L. H. Britton of the same organization, who was originally scheduled to address the meeting.

Mr. Hilton attributed the development of Minneapolis and St. Paul to superior waterpower and the favorable freight rates the Twin Cities could exact because of advantages in river transportation. The need for the decentralization of huge industrial enterprises, the waterpower and the possibilities of profitable river traffic have attracted Mr. Ford to the Twin Cities, and the building up of that river traffic is one of the most important advantages expected from the location of the new Ford factory there. The resumption of river traffic would encourage the export of grain via New Orleans, instead of the more expensive Lake route. The Ford plant would also mean building up Minneapolis and St. Paul through the men brought in and the publicity given the new Ford project.

The May meeting of the Minneapolis Section will be held at the Manufacturers' Club on May 2, beginning at 8 p. m., after the usual informal supper. The North East Electric Co.'s film, Electricity in the Motor Vehicle, will be shown, and J. L. Larson of the college of agriculture, University of Minnesota, will speak on Some Experiences in First Breaking Peat Land. Mr. Larson's talk will be based on exhaustive tests that have led to conclusions of fundamental importance to tractor designers.



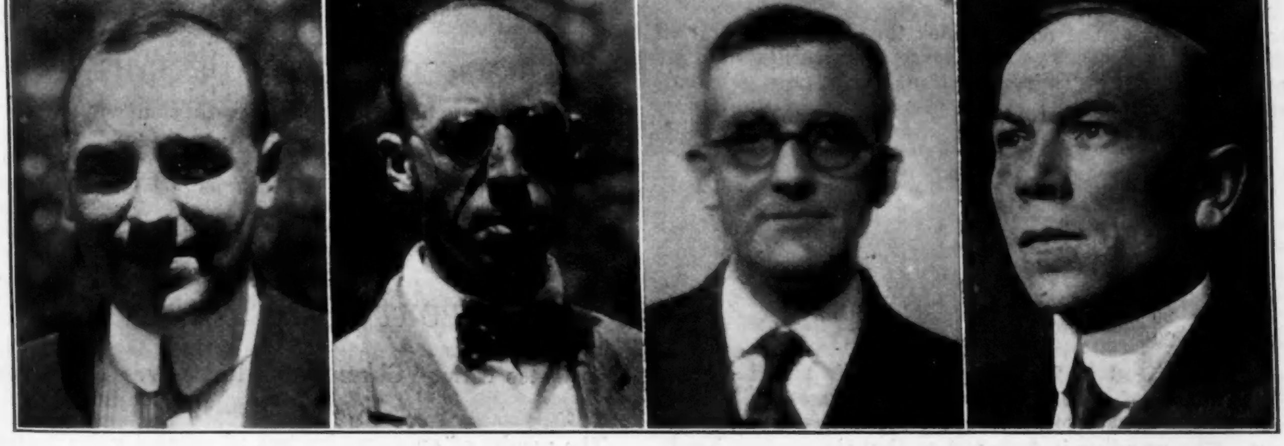
E. J. Lees Glenn Muffly
THE TWO AUTHORS OF THE PAPER PRESENTED AT THE APRIL MEETING OF THE DETROIT SECTION

GROUND GEAR ADVANTAGES EXPLAINED

Improved Efficiency and More Quiet Running Warrant Slight Additional Expense

Objectionable sound-waves are produced by errors in gear teeth greater than 0.0003 in. and, to avoid the occurrence of errors beyond this limit, it is necessary to generate tooth curves after hardening instead of before. This was the opinion expressed by Glenn Muffly, of the Lees-Bradner Co., who addressed the Detroit Section of the Society on the evening of April 6. As evidence that the gear-noise subject is a live one, over 250 members and guests attended this meeting to hear the description of one process of gear grinding and a discussion of tooth forms.

In the process described by Mr. Muffly, the gear-tooth profile is generated by rotating the gear past a large grinding wheel whose flat surface represents the face of a flat-sided rack tooth meshing with the gear that is being ground. The gear is indexed automatically and moved one space after each of the tooth surfaces has been rolled over the wheel twice. The indexing mechanism has been studied carefully to control the spacing of the teeth to a high degree of accuracy. The grinding wheel is 30 in. in diameter, its large size making it unnecessary to dress the wheel until one or more gears have been finished. The dressing operation is simple since the grinding or working face of the wheel is a perfectly flat surface. It is possible to generate modified involute tooth forms on this machine so that the tooth profile will be a correct involute when the gear is working under



R. E. Wilson, Mid-West — C. T. Myers, Metropolitan — T. J. Litle, Jr., Detroit — O. M. Burkhardt, Buffalo
SOME OF THE RECENTLY ELECTED SECTION CHAIRMEN

load, the modification being made to compensate for the deflection of the loaded tooth. These modifications are very minute as compared to those that have been made in the past, and Mr. Muffly said that the tooth form his company recommended is so near the true involute that it would pass as a perfect involute tooth when tested by the usual methods.

A demonstrating device that represented two rolling wheels acting as involute base circles with steel tapes running between them to represent tangents to these base circles was shown at the meeting. It was possible to generate tooth curves with this model and compare their relative forms when generated with the base circles placed at several different center-to-center distances. In other words, the base-circle diameters were kept constant, but the circles themselves were fixed at varying centers to generate a series of involute curves. In this way, Mr. Muffly demonstrated that an involute gear has no inherent pitch diameter of its own and only acquires one when it is meshed with another gear, a hob, a cutter or a grinding wheel. There is nothing stable about the pitch diameter in the involute system, and two gears running on a center distance 0.010 in. greater than standard, theoretically are running just as accurately as if they were meshed on the intended center distance, except, of course, that teeth run in this way should be made thicker to reduce the backlash to a reasonable amount. The change in center distance simply causes a change in the pressure-angle and moves the rolling surfaces farther down the same basic involute curve.

New Possibilities With Ground Gears

Gear grinding not only aids the solution of the noise problem, but it opens the way for design changes that were impractical because hardened steel gears could not be made to run quietly. More development in the application of four-speed transmissions will take place and engines can then be run at their most economical speeds a greater part of the time. The public has demanded flexible performance on high gear because of the objection to the noise of the transmission when it is operated in second gear. Grinding of gear teeth opens up the possibilities of a really high fourth speed and we may even see transmssions in which there is no direct drive, thus making all speeds uniformly efficient. Placing the propeller-shaft on another and lower center will permit the lowering of the body floor and the reduction of the universal-joint angle. Ground gears are also more efficient because they are mechanically correct and this high efficiency will result in increased fuel economy. Transmission shafts will have to be designed so that all of the gear teeth can be reached with a grinding wheel; cluster gears made in one piece with the shaft will have to go. It is possible that there will be a return to spur gears for timing purposes because of the more quiet operation due to the ground teeth. The change from helical to spur gears can be made very easily since the grinding process handles an odd diametral pitch as well as any standard pitch.

The discussion at the meeting took the form of submitted questions and answers, the scheme so successfully used at recent meetings of the Detroit Section. E. J. Lees, who collaborated with Mr. Muffly in the preparation of the paper, gave the following data relating to time required for grinding:

Number of Teeth	Time per Tooth, Sec.
15	14.4
17	13.2
18	10.8
21	9.6
25	9.6
29	8.4

These teeth are 6 to 8 pitch, the wheel is rotating at a peripheral speed of 5000 ft. per min. and passes twice over one side of the gear tooth. About 0.003 in. is removed by each cut. The grinding is done wet so that the surface hardness of the tooth is not affected. One manufacturer has determined the cost of grinding as $1.75 per transmission; another said it cost a few cents more than the cost of the finishing cut that was replaced by grinding. In any case, a considerable saving is made by eliminating tear-downs of completed transmissions that are too noisy to pass the final inspection. Mr. Muffly believed that gear life was lengthened by grinding, because the elimination of spacing and profile errors insured smooth running, uniform velocity and the elimination of the alternating loads that would be present without these conditions.

The statement was made that bevel gears could not be ground on the machine described, or on any other now on the market, but that this would probably be accomplished eventually. Backlash can be reduced materially with ground gears provided the other machine work is accurate and the center-to-center distance of the gear-shafts accurately maintained. No comparative efficiency tests had been made between individual gears or transmissions with and without grinding the teeth. It was the speaker's opinion that a small pressure-angle is desirable from the standpoint of quietness because it makes it easier to hold down the backlash. On the other hand, in transmission practice the gears have relatively small numbers of teeth and the tooth load is large, so it is advisable to use a larger pressure-angle to avoid interference and distortion. The large pressure-angle avoids under-cutting the teeth on the pinions and provides a stronger tooth form. About 20 deg. is a good pressure-angle for transmission gears and about 14½ deg. is suitable for timing gears. Odd pressure-angles are frequently used when it is found that the standard angle would result in tooth interference.

Officers of the Detroit Section were elected at the April meeting for the coming Section year. Thomas J. Litle, Jr., was accorded the honor of election to the chairmanship. Mr. Litle has been active in the affairs of the Detroit Section for the past year, serving as its secretary. He was partly responsible for the success of the Production Meeting held in Detroit last fall and is an active member of the Research and the Meetings committees of the Society. Don T. Hastings was elected to the office of vice-chairman, Milton Tibbets becomes the Section's treasurer, and K. L. Herrmann, who has been instrumental in bringing production subjects before the local and national meetings, will assume the duties of secretary.

BUFFALO LEARNS BY SEEING

The development of electricity in general and particularly as applied to the automobile was shown at the Buffalo Section's meeting on April 13 in the North East Electric Co.'s new film. After a reel that outlined the development of electricity to its present important place, six reels were devoted to a graphic study of ignition, the starter and the generator. G. R. Fessenden of the North East Electric Co. explained the processes demonstrated by animated diagrams and the labors of the North East Electrified Dwarfs, clearing up some of the more obscure points in ignition and the operation of the separate and single unit starter-generator.

There will be no meeting of the Buffalo Section in May.

FOUR-WHEEL BRAKES DETROIT TOPIC

The next meeting of the Detroit Section will be devoted to a paper and discussion of hydraulic four-wheel brakes. The meeting will be held on the evening of May 17 in the General Motors Building. The paper will be read by M. Lougheed, engineer of the Four-Wheel Hydraulic Brake Co. The meeting will start at 8 o'clock and will be preceded by an informal dinner at 6:30.

TRANSPORT CORPS TESTS VALVES

Concludes Silicon-Chromium Alloy Gives Best General Service Result

The results of an extensive test of exhaust-valve materials made by the Motor Transport Corps were presented to the members of the Washington Section by Arthur W. S. Herrington at the meeting held on April 6. A large number of

valves of different construction and materials were subjected to warpage, burning and scaling tests to select the valve design and metal best suited to the service of the Corps. The tests for warpage were made by running a set of each kind of valve in a Class B truck engine, the compression of which had been raised to 5.33 to 1 to increase the severity of the test and shorten the time required. Each valve was checked for eccentricity of the stem and the seat, properly ground in place, the engine run for 8 hr. at 1000 r.p.m., and the valves again checked for eccentricity.

Resistance to burning was judged by running valves in the engine after relieving their seating faces to a depth of about 0.02 in. on a sector 1½ in. long. This allowed leakage of the exhaust gases past this sector and resulted in exaggerated burning and scaling of the valve face. The change in the depth of this groove after the test run gave an indication of the relative resistance of the valves to burning and pitting.

To check the resistance of the several materials to excessive heating, samples were placed in a gas furnace and maintained at a temperature of 1550 deg. fahr. for a period of 5½ hr. After that severe treatment, they were removed and all of the loose scale was brushed off of them. The weight was then taken and compared with that recorded at the start of the test, the difference indicating the relative ability of the different materials to withstand oxidation at high temperatures. It was noted that the steels with the higher content of sulphur were the ones that were found to be most badly scaled.

It was concluded as a result of these tests that the most desirable material specification for valve-steel at present, judged by the method used and for the service encountered in Motor Transport Corps vehicles, was as given at the top of the next column. This alloy is known commercially as silichrome.

Officers of the Washington Section for the coming year were elected at this meeting. C. H. Warrington will take the

Carbon, per cent	0.450
Manganese, per cent	0.560
Phosphorus, per cent	0.029
Sulphur, per cent	0.010 max.
Silicon, per cent	4.020
Chromium, per cent	9.300
Nickel, per cent	0.050

helm as chairman and this insures an active year, judging by the interest that Mr. Warrington has taken in the Section's activities in the past. Other officers elected were: A. W. S. Herrington, vice-chairman; and C. H. Young, secretary and treasurer.

The next meeting of the Washington Section will be held on the evening of May 4 at the Cosmos Club. Major F. S. Besson will address the members on the subject of Highways and Traffic.

W. F. GERHARDT ON MILITARY AIRPLANES

May 1 is the date of the next Dayton Section meeting at the Engineers' Club. At 8 o'clock, after an informal supper at 6:30 p. m., members of the Dayton Section and their guests will hear W. F. Gerhardt on Fundamental Principles of Design of Military Airplanes. Mr. Gerhardt's experience as an aeronautical engineer with the flight test section of the Air Service, at McCook Field, has amply qualified him to speak of the principles on which military airplanes must be built for successful flight.

F. S. DUESENBERG AT INDIANA MEETING

Engineering Information from the Race Track is the topic on which F. S. Duesenberg, chief engineer of the Duesenberg Automobile & Motors Co., Inc., will speak at the May 3 meeting of the Indiana Section. The meeting will be held at the Lincoln Hotel, Indianapolis, and will begin at 8 p. m., after an informal dinner at 6:30.

APRIL COUNCIL MEETING

THE meeting of the Council held in Cleveland on April 25 was attended by President Alden, First Vice-President Crane, Vice-President Masury, Councilors L. R. Smith and A. J. Scaife, Past-President Bachman and Mr. O. A. Parker.

The financial statement as of March 31, 1923, showed a net balance of assets over liabilities of $121,198.38, this being $2,912.51 less than the corresponding figure on the same day of 1922. The income of the Society for the first 6 months of the current fiscal year amounted to $137,478.97. The operating expense during the same period was $138,266.69.

One hundred and thirty-six applications for individual membership, two for affiliate membership and one for student enrollment were approved. The following transfers in grade of membership were made: From Junior to Associate, Stuart Cowan; Associate to Member, F. R. L. Daley, Frederick H. Ford, Norman W. Lyon, A. L. Swank, George C. Lees, James L. Myers, Paul M. Stone, Paul B. Taylor, George Hutton, J. H. Holloway, A. R. Keagy, H. C. Olivier, E. S. Anderson, C. E. Patterson and M. J. Marty; Junior to Member, J. McElroy, S. R. Swenson, G. W. Klinger, H. A. Hansen and Earl H. Smith; Associate to Service Member, George W. Graham; Foreign Member to Service Member, D. D. Pullen; Member to Foreign Member, Joseph Kirschmann. Eleven transfers were considered but will not be completed pending observance of additional formalities.

It was reported that up to April 25, 1923, 323 applications for membership had been received during 1923, as compared with 268 received during the first 4 months of 1922, and 324 during the corresponding period of the previous year.

The following appointments to the Standards Committee were made:

- Aeronautic Division—Paul C. Zimmerman
- Ball and Roller Bearings Division—H. Wickland
- Iron and Steel Division—R. J. Allen
- Lubricants Division—A. B. Dawson
- Motorboat Division—James W. Hussey and H. F. Sailor
- Nomenclature Division—H. M. Crane
- Truck Division—C. B. Veal

The following appointments were confirmed:

- Aeronautic Division—Otto H. Hamm and E. W. Rounds
- Isolated Electric Lighting Plant Division—L. W. Holt
- Motorboat Division—W. A. Roos, Jr.

The following were designated to serve as members of the Tire and Rim Division of the Society:

J. G. Vincent, *Chairman*
B. B. Bachman H. M. Crane
A. J. Scaife

The subject of the simplification and reduction of the number of tire and rim fits was assigned to the Division.

Walter C. Ware was appointed to serve this year as Second Vice-President representing Marine Engineering, in place of E. J. Hall who resigned.

The next meeting of the Council was tentatively scheduled to be held at Spring Lake, N. J., on June 18.

Cracking Processes in the Petroleum Industry[1]

By Frank A. Howard[2]

As used in the petroleum industry, the term "cracking" signifies generally the conversion by decomposition of a heavy or viscous oil of high boiling-point into a lighter, free-flowing oil of lower boiling-point. Specifically, the term is applied almost universally to that particular species of decomposition by which gas oil or fuel oil is converted to yield a substantial percentage of gasoline.

The art of cracking goes back approximately 100 years, not of course in the modern petroleum industry, which has not had that length of life, but in the allied gas and coal-distillation industries. Animal and vegetable oils, waxes, fats and resins appear to have been subjected to an operation that we should today call "cracking," in the very earliest days of the gas industry, for the purpose primarily of converting them into illuminating and fuel gas. Almost as early, various natural bituminous substances, such as coal, shale, lignites and more rare mineral deposits that came very near to being solidified petroleum oil, were subjected to destructive distillation, both for gas production and for the production of light-oil distillates. The earliest general use of this method of destructive distillation for the purpose of causing the decomposition of complex bitumens into lighter oils appears to have taken place in connection with the shale and coal oil industry in England, where cracking processes of this description were very early utilized to increase the yield of refined oil or kerosene.

Highly Developed by Americans

Cracking for this purpose became a standard operation in the petroleum industry soon after it got on its feet commercially in America, and the process was highly developed in American refineries. By the aid of this method, the supply of refined oil, which was at that time the petroleum product in greatest demand, was very greatly increased. In the case of many crude oils the yield of kerosene obtained by cracking equalled the yield of natural kerosene, so that in effect the kerosene production was in these instances actually doubled by cracking.

In the early years of the present century, when the demand for gasoline began to outstrip the demand for kerosene, it was natural that the oil-refiner should turn to his prior cracking processes for inspiration and help in solving the new problem. The earliest process for cracking to produce gasoline that proved successful on a large commercial scale was that developed by Dr. William M. Burton and his associates, of the Standard Oil Co. of Indiana. This process was a pressure-distillation method, the details of which were worked out so successfully that within 2 or 3 years there were several hundred stills operating according to the method in use, not only by the Indiana company but by a large number of licensees as well, located in all parts of the United States. The success of the process and its widespread use may be attributed not only to its intrinsic merits, but also to the circumstances that its details were worked out in such a manner that it fitted into existing refinery processes and organizations so perfectly, requiring the minimum of special knowledge in either construction or operation, and the minimum change in the accepted refinery practices aside from the pressure distillation itself.

The Burton Process

The Burton process, of course, was not the only one that came forward at this time, for the subject of an increased gasoline supply was one of great importance to the whole industry, and refiners, as well as chemists, engineers, and outside inventors and scientists of all descriptions, were diligently at work on other processes. The historical background of the cracking art, involving not only petroleum refining but the earlier industries of gas manufacture and coal and shale distillation, gave a fertile field in which inventors seeking to improve cracking for the production of gasoline could operate. It will be remembered that the Federal Government itself became interested in this matter, through the Bureau of Mines, and that much publicity was given to a process known as the Rittman process, the initial work on which was done under the auspices of the Bureau of Mines.

Unfortunately, in many instances, perhaps the majority of instances, the investors and promoters of the numerous cracking processes that began to clamor for public attention and financial backing very soon after the Burton process became generally established, either were unfamiliar with or failed to point out the historical background of the problem. It was believed by most persons not familiar with the details of the industry that cracking was an entirely new phenomenon and method; that the Burton process was the only known means of accomplishing it; and that anyone who was able to produce gasoline by cracking in a manner different from that of the Burton patents would be assured of a fortune.

The Facts of the Matter

The facts of the matter were very different; cracking was not essentially new, nor was it by any means true that the Burton process was the only method by which gasoline could be obtained from the heavier oils. Almost anyone of the hundreds of prior cracking processes that had grown up in the three related industries of petroleum, gas and coal were available, sometimes without any change at all and sometimes with only the very simplest changes, for the production of gasoline from heavy oils. As in every other practical proposition, the dollars-and-cents results were the final criterion. For one reason or another, almost none of these competitive processes could be actually used on a large scale by the average petroleum-refiner with any profit to himself. The gasoline yield was too small, the quality bad, the losses too high, the processing costs excessive, the equipment too dangerous or too costly or some other single disadvantage or combination of disadvantages worked to outlaw the process from the practical refinery. At least half a dozen sizable fortunes have been sunk in efforts to convince the refining interests of the Country of the practical value of the more energetically promoted of these processes. Much that was of real merit was involved in many of the processes, and some of them actually gained a precarious foothold in the industry.

It was inevitable that a development of this kind, involving such a large industry and of such great importance financially, should become the subject of a host of patents. Several hundred patents have been issued dealing with cracking processes in the last 10 years. The lack of any general knowledge on the part of the public as to the nature of a patent right is in a large measure responsible for the confu-

[1] From an article in *The Lamp*, published by the Standard Oil Co. of New Jersey.

[2] M.S.A.E.—Manager of the development department, Standard Oil Co. of New Jersey, New York City.

sion that has existed with respect to cracking patents and with respect to their speculative or investment value. It should be understood that a patent is not the grant of a right by the Federal Government to practise a certain invention, make a certain machine or use a certain process. Every person has an inherent right to engage in any lawful business, and this right is neither extended nor limited by the grant of a patent to him for an invention that he proposes to use. The right that the grant of a patent does establish is not the right to practise the patented invention, but solely the right to prevent others from practising the specific novel point of the invention.

It is almost universally the case that an invention consists of a combination of something that is new with something that is old. In the art of cracking oil, the patents, without any exception so far as we know, do not even purport to cover fundamentally the operation known as "cracking." They obviously could not do so, for this operation, under the same or another name, is at least 100 years old. What the patents do cover, each of them, is some particular combination of steps or pieces of equipment arranged for use in some definite fashion. Perhaps no single one of the pieces of equipment or the steps of procedure will be new in themselves; perhaps the novelty will consist only in its application in that particular combination.

In other cases, the novelty may consist in the addition of some single new step or piece of equipment to an apparatus or process that was in toto old with the exception of that new part. For example, in the cracking art, probably two-thirds of the patents that have been issued relate to improvements in the same general method used in the Burton process, the distillation of the heavy oil under pressure. These improvements take all forms; they deal with the temperatures and pressures at which the distillation takes place, the form of the equipment used, the treatment of the resulting products and every imaginable variant. The Burton patents themselves, although generally regarded as the pioneer patents in this field of gasoline production by pressure distillation, do not purport to cover the mere act of pressure distillation as carried out in a particular fashion, which, in the judgment of the Patent Office, was new with Burton and his associates.

Mostly Infringements

It follows from the above that almost all of the patented cracking methods, which have formed the subject of the large number of patents issued within the last few years, are themselves infringements of some one or more other patents, depending upon the basis upon which the inventor started to work. A situation of this kind naturally becomes more complex in proportion to the number of patents that are coexisting in the same field at any particular time. The importance of the cracking art naturally attracted inventors to such a great extent that there is perhaps no single patent situation which is more confused than this one. The situation has been made even worse by reason of the fact that the Patent Office has been laboring under difficulties in the way of inadequate funds and an inadequate staff during the past 5 years, resulting not only in the grant of some patents, the validity of which may be seriously questioned, but also in almost indefinite holding-up of applications for patents.

A Licensing Patent

The Standard Oil Co. of New Jersey has been a licensee under the Burton patents and has operated large numbers of Burton stills for many years. It has during that period devoted considerable amounts of time and money to research and experiments on cracking and as a result of this work has been able to improve greatly the efficiency of operation of its Burton equipment. A further and more important result of the same work, however, has been the development of a process, known as the "tube-and-tank process," that is just now beginning to be used extensively in the refineries of the Company. Based on the experience with it up to the present time, it is believed that this method will be in many respects superior to the Burton method. It is not the intention of the Company to attempt to monopolize the tube-and-tank cracking method but on the contrary, a liberal licensing policy has been adopted with respect to this process.

RESERVE OFFICERS TRAINING CORPS

The lessons taught by the World War took root in the minds of our Country's legislators, with the result that the Reserve Officers Training Corps, previously a practically dormant and inactive organization, became an important force, both in our colleges and in the military world. Generous appropriations contributed the stimulus toward making it an active and well-planned organization that immediately took its rightful place in college work.

Despite the aversion for all things of a military nature, created by the years of warfare, the courses of military instruction were made so attractive that students were glad to take them. Uniforms, commutation of rations and summer camps were features that appealed to the average college man. The courses, instead of being confined to close-order drill and tiresome ceremonies, were broadened to include lectures and practical work on subjects that were not only of vital importance to an officer, but interesting to the student. These things have contributed toward making military one of the most popular courses in the modern college.

The courses as presented in the colleges are intended to give the basis upon which may be added the finishing touches necessary to make good officers. These men, placed in reserve, could be called forth in time of war, given a short intensive training suited to the needs of their branch of the Service, and made ready in a short time for active and useful duty. Aside from the military value of this force of Reserve Officers, the civic value of the training received under the Reserve Officers Training Corps is immense. It has been said that a man who wins his commission in the Artillery has sufficient training to be a good civil engineer. The same sort of thing might be said in connection with the Signal Corps and electrical engineers. The Motor Transport Corps offers a course in automobile mechanics hard to beat in any technical school.

The discipline and obedience to authority exemplified in the old-fashioned military regimes, are not entirely dispensed with in the modern course. Enough close-order drill and infantry maneuvers are assigned the student to give him a thorough idea of the value of discipline and the poise that is the making of a good officer. This work is given in the earlier part of the course, while the last 2 years are devoted more to the theory and specialized study of the subjects directly pertaining to the branch of service that the student intends to enter.—C. Y. Thomason in *Coast Artillery Journal.*

TRAFFIC SIGNALING

THOSE responsible for the control of the rapidly increasing motor-vehicle traffic on our city streets and State and county highways have been confronted with a problem that under the best conditions is neither simple nor easy. No traffic in the history of the world has developed at such a rapid rate as highway traffic. So, it is not surprising that, in meeting this unprecedented growth, methods have been adopted which, if more time had been available, would have shown a greater degree of uniformity and a closer adherence to some of the principles that have, through a long period of years, evolved into established practice in the control of other classes of traffic.

We shall probably always have traffic laws, regulations and lettered signs for the highway, but we may expect continued development of signaling, both audible and visual, for highway-traffic control. Users of highway vehicles are not the only people who have had to face the problems of traffic control and signaling. Many of the existing marine and railroad signaling methods are the result of years of study and have become stabilized through legislative enactments. An acquaintance with their underlying principles is helpful in any study of traffic control and signaling.

In general, the conditions that affect traffic and need to be indicated to the vehicle operator are those that in any way retard or obstruct free traffic movement. Naturally, any conditions that affect the integrity of the roadway as a structure or support for the vehicle constitute an obstruction. The most frequent class of obstructions to vehicle movement is the presence of another vehicle. The degree in which one vehicle in the path of another constitutes an obstruction varies greatly with the nature of the channel of traffic. The braking power of the vehicle, that is, the distance in which a stop can be made, is a factor in determining the location of any form of traffic signaling and the indication that it should display. In all traffic regulation it is necessary to recognize that one vehicle may at certain times have the right of way or precedence over another.

Railroad trains are classified according to what is called "superiority." Precedence of one train over another may be conferred by right, class or direction. Superiority by right is conferred by train-order. First-class trains are superior to second-class trains; as between trains of the same class on a single track, those moving in a given direction have superiority. Without our recognizing the fact, perhaps, our highway vehicles group themselves into the same classes. The whistle of the traffic policeman, or his hand signal, establishes precedence by right. Our fire engines, ambulances and United States mail wagons would in railroad language be called first-class trains. They have the right of way over other vehicles. In a number of cities traffic on streets running in a given direction has precedence over traffic on streets running at right angles to them.

Signal Systems

The three principal systems of signals used for the control of traffic are (*a*) fixed signals, (*b*) vehicle signals and (*c*) hand signals. Fixed signals indicate conditions affecting the movement of traffic; under this heading may be grouped lighthouses, beacons and buoys for marine traffic; pylons, ground-lights and other landing-field signals for air traffic; block-signals, interlocking signals, train-order signals, switching signals and signs on railroads, and traffic signals, road-signs and railroad-crossing signals on highways.

Signals displayed by vehicles indicate their class, location or direction of movement. This class includes the running and the anchor lights of vessels, the running lights of aircraft, the classification signals and markers of railroad trains and the usual lights displayed by highway vehicles. Hand signals may be defined as any signals given with the hand, a flag, a lamp, or a disc by the operator of a vehicle or by a person controlling the movement of traffic.

Our railroad friends have some rather good definitions of signaling; the handling of heavy trains at high speed of course requires very definite and simple signal-codes. There are three conditions that railroad signals are primarily intended to denote: (*a*) that the way is not clear; (*b*) that the train should be brought under control so as to enable a stop to be made quickly; and (*c*) that the way is clear. The indications of these conditions are, respectively, "stop," "caution" and "proceed." When the railroad man uses the word "indication," he does not mean the form, color or appearance of a signal, but the wording or language that the signal speaks. He uses another word to define the form, color, motion, position or other appearance of the signal, namely, "aspect." In describing a situation in which it is proper for a train to proceed, he would say that the *condition* is *clear*, that the *indication* is *to proceed* and that the *aspect of the signal* is *an arm in a vertical position* by day and in addition, at night, a green light. These terms appear to be sufficiently clear and precise to be used in connection with all forms of traffic signaling to which they may apply.

It is of course highly desirable that, so far as possible, uniformity in all types of traffic signaling exist. We hardly need "port" and "starboard" lights on automobiles; though, if numbers of them were maneuvering at large over a field instead of running in parallel paths on highways, such lights might be very desirable. There is little chance for conflict between marine and land signals. Thousands of miles, however, of our important highways run parallel to and closely alongside of our steam railroads, and many hundreds of miles of electric railways actually occupy our streets and roads. Furthermore, we have in the United States thousands of crossings of highways and railroads at grade. It is perfectly clear that our systems of railroad and highway signaling, as regards fixed signals, vehicle signals and hand signals, should be of sufficient uniformity to avoid misunderstanding or conflict, wherever signals used in the control of one class of traffic may be seen and wrongly interpreted by the operators of vehicles in the other class of traffic.

It is also highly important in any system of signaling never to use an indication that is more restrictive than is actually required by the conditions. I have never encountered anything more absurd in signaling than to follow another car down a long hill, my own car and that ahead running at about 25 m.p.h., with the leading car displaying in flaming red letters the word "stop." This is almost the ultimate in crying "wolf," and there is nothing worse in any system of signaling, unless it be a direct conflict of indications, than continually crying wolf by giving a more restrictive indication than the conditions warrant. Certainly, the most restrictive indication that the car ahead should have displayed is "caution." I believe that a caution indication rather than a stop indication, should be the one displayed by the tail-lamps of highway vehicles.

The question of signaling at grade-crossings of railroads and highways demands the most careful study and the determination of a sound basis for the indications to be displayed and the aspects of the signals to denote them. Probably there is no phase of the signal problem that is more confused, nor on which there has been so much loose thinking.

Signaling in some of its forms is a very old art. Railroad signaling as an art is less than 100 years old. Highway-traffic signaling is still in its infancy; and it is always true that in a new art those who practice it are prone to rush into details before establishing the sound underlying principles that should govern practice.

I am not attempting herein to describe signaling apparatus of any type, nor to suggest the form, color, position or motion to be used for any particular signal-aspect, nor the aspect to be employed to give any particular indication. It has been my intention simply to indicate some of the basic conditions that underlie the control of traffic of all kinds in the hope of stimulating an interest on the part of those concerned in highway traffic, in the study of the history of traffic control and the development of the art of signaling. We can never build a stable structure except upon a sound foundation.—From an address by Azel Ames before the American Automobile Association, at Jacksonville, Fla.

Applicants *for* Membership

The applications for membership received between March 15 and April 14, 1923, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

ANDERSON, J. A., student, University of Minnesota, *Minneapolis*.

ARATA, L. D., student, University of Cincinnati, *Cincinnati*.

ARGELAN, PETER ARTHUR, student, University of Cincinnati, *Cincinnati*.

BECK, MILTON, chief engineer, Stanley Motor Carriage Co., *Newton, Mass*.

BERSIE, HUGH G., engineer, Haskelite Mfg. Corporation, *Chicago*.

BIRD, LEON F., student, University of Cincinnati, *Cincinnati*.

BOLGER, JOHN F., vice-president, Allbestos Corporation, *Logan, Philadelphia, Pa*.

BOYD, PAUL M., student, University of Minnesota, *Minneapolis*.

BRIER, ALBERT T., instructor of auto mechanics, Elwood Public Schools, *Elwood, Ind*.

BUCHANAN, ALEXANDER D., student, University of Michigan, *Ann Arbor, Mich*.

BURNS, CHARLES E., JR., mechanical laboratory assistant, Bureau of Public Roads, *City of Washington*.

COLLIER, J. F., manager service, Reo Motor Car Co., *Lansing, Mich*.

COLE, WHEELER J., student Tri-State College, *Angola, Ind*.

CONE, LOGAN J., student, University of Cincinnati, *Cincinnati*.

COWAN, GERALD A., student, University of Cincinnati, *Cincinnati*.

CRABTREE, L. B., student, University of Cincinnati, *Cincinnati*.

CRAFT, EDWARD B., chief engineer, Western Electric Co., *New York City*.

CRAIN, ALLAN MEYER, student, University of Cincinnati, *Cincinnati*.

DAVIS, J. B., production manager, Standard Textile Products Co., *New York City*.

DAVIS, LEWIS K., managing director, Roadless Patents Holding Co., *City of Washington*.

DEBRUL, WILLIAM E., student, University of Cincinnati, *Cincinnati*.

DIBBLEE, WALTER AUGUSTUS, JR., student, University of Cincinnati, *Cincinnati*.

DODS, JOHN P., vice-president, Brightman Mfg. Co., *Columbus, Ohio*.

DUNHAM, TAYLOR H., student, University of Cincinnati, *Cincinnati*.

DURHAM, PERCY J., president and general manager, P. J. Durham Co., *New York City*.

EBERHARDT, FRED ROSS, manager gear department, Newark Gear Cutting Machine Co., *Newark, N. J*.

EXLEY, LUCIUS M., student, University of Cincinnati, *Cincinnati*.

FABER, L. E., mechanic, Yellow Cab Mfg. Co., *Chicago*.

FREEMAN, F. P., superintendent of motor equipment, Kaufman's Department Stores, Inc., *Pittsburgh*.

FREY, ARWIN P., student, University of Cincinnati, *Cincinnati*.

FRIESTADT, MORTIMER, chief mechanic, H & C Auto Repair Co., *Brooklyn, N. Y*.

GAGE, N. E., sales manager, National Tool Co., *Cleveland*.

GANTES, RAMON, mechanical engineer, Chilian Consulate, *New York City*.

GIALDINI, B. THOMAS, student, University of Cincinnati, *Cincinnati*.

GILBERTSON, GEORGE B., student, University of Minnesota, *Minneapolis*.

GLYNN, FREDERICK K., engineer of motor vehicles, New York Telephone Co., *New York City*.

HUKILL, H. D., in charge of automotive division, Westinghouse Air Brake Co., *Wilmerding, Pa*.

HULTON, RALPH, branch manager, Lovejoy Detroit Co., *Detroit*.

IRISH, L. A., manager, New York Yellow Cab Co., Sales Agency, Inc., *New York City*.

KIZER, KARL K., president, Kizer Equipment Co., *Chicago*.

LONTZ, DUDLEY M., student, University of Cincinnati, *Cincinnati*.

MCVEIGH, LUKE M., student, Cornell University, *Ithaca, N. Y*.

MACKENZIE, ROBERT E., advertising manager, Timken Roller Bearing Co., *Canton, Ohio*.

MACMILLAN, R. D., director of sales and service, Albert Frank & Co., *New York City*.

MEAD, RICHARD O., sales manager, American Wood Rim Co., *Onaway, Mich*.

MEYER, HENRY F., truck equipment engineer, Van Dorn Iron Works, *Cleveland*.

MORAN, RONALD JAMES, student, Tri-State College of Engineering, *Angola, Ind*.

MUELLER, J. WESLEY, student, University of Cincinnati, *Cincinnati*.

NEVIN, CHARLES A., layout draftsman, L. W. F. Engineering Co., *College Point, N. Y*.

NOELKE, H. M., experimental assistant, International Motor Co., *New York City*.

NORTON, BENJAMIN M., sales manager, Four Wheel Hydraulic Brake Division, U. S. E. Corp., *New York City*.

OGAWA, YOSHIO, student, Tri-State College, *Angola, Ind*.

OSTBY, OSCAR F., general sales manager, Prest-O-Lite Co., Inc., *Indianapolis*.

PATON, CLYDE R., teaching assistant in mechanical engineering, University of Michigan, *Ann Arbor, Mich*.

PATTERSON, H. R., chief engineer, DeJon Electric Corporation, *Poughkeepsie, N. Y*.

PIETZ, LOUIS F., road engineer, International Harvester Co., *Sioux City, Iowa*.

SCHMID, WILLIAM A., JR., student, University of Cincinnati, *Cincinnati*.

SCHREINER, EDWARD, student, University of Cincinnati, *Cincinnati*.

SCHWEITZER, GEORGE A., student, University of Cincinnati, *Cincinnati*.

SMELLIE, DONALD G., assistant engineer, Holmes Automobile Co., *Canton, Ohio*.

TACKENBERG, RICHARD CHARLES, student, University of Cincinnati, *Cincinnati*.

TAYLOR, WILLIAM WHITWORTH, student, University of Cincinnati, *Cincinnati*.

THIERSCH, WALTER, student, University of Cincinnati, *Cincinnati*.

TITUS, CURTIS TURNER, student, University of Cincinnati, *Cincinnati*.

TOWNSEND, ARTHUR L., instructor in mechanical engineering, Massachusetts Institute of Technology, *Cambridge, Mass*.

TRIESLER, A. WAGER, student, University of Cincinnati, *Cincinnati*.

TYLER, DONALD WILSON, student, University of Cincinnati, *Cincinnati*.

VINCENT, FIRST-LIEUT., THOMAS K., Ordnance Department, Raritan Arsenal, *Metuchen, N. J*.

WAGNER, JOHN WESLEY, student, University of Minnesota, *Minneapolis*.

WAITE, GORDON TARBELL, student, University of Michigan, *Ann Arbor, Mich*.

WASMER, CLARENCE T., student, University of Cincinnati, *Cincinnati*.

WATSON, CLIFFORD E., student, Pratt Institute, *Brooklyn, N. Y*.

WILLIAMS, S. M., branch manager, Autocar Sales & Service Co., *New York City*.

WILSON, HARLAND D., chief chemist and chemical engineer, Prest-O-Lite Co., Inc., *Indianapolis*.

WILSON, J. F., body engineer, Chevrolet Motor Co., *Detroit*.

WOODHULL, J. R., student, University of Cincinnati, *Cincinnati*.

Applicants *Qualified*

The following applicants have qualified for admission to the Society between March 10 and April 10, 1923. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member; (E S) Enrolled Student.

CADENHEAD GEORGE L. (E S) student, University of Illinois, Urbana, Ill., (mail) 311 East Green Street, *Champaign, Ill.*

DUBRUL, WILLIAM E. (E S) student, University of Cincinnati, *Cincinnati,* (mail) 835 Beecher Street.

DYMENT, ALBERT ELLIOTT (J) sales engineer, Goulds Mfg. Co., Seneca Falls, N. Y., (mail) 12 South Clinton Street, *Chicago.*

ECKERT, O. E. (M) lubrication engineer, Transcontinental Oil Co., Benedum-Trees Building, *Pittsburgh.*

FISHER, R. B. (J) student engineer, H. H. Franklin Mfg. Co., *Syracuse, N. Y.,* (mail) 327 South Avenue.

GRASS ALBURN ROGERS (E S) student, University of Cincinnati, *Cincinnati,* (mail) 2338 Stratford Avenue.

GROSS C. (A) service manager, Welbon Dayton Motor Car Co., *Dayton, Ohio,* (mail) 724 Idaho Avenue.

GROSSER, NELSON O. (A) service engineer, B. Robinson Supplies, Ltd., *Moose Jaw, Sask.,* Canada.

HAMILTON, GEOFFREY JOHN (E S) student, Cornell University, *Ithaca, N. Y.,* (mail) 109 Cayuga Heights Road.

HEAVRIN, W. C. (M) lubrication engineer, Standard Oil Co. of Indiana, *Davenport, Iowa,* (mail) 2116 Eastern Avenue.

ISDAHL, EINAR (J) student, University of Wisconsin, *Madison, Wis.,* (mail) 703 State Street.

KEDZIE, LAURENCE FYFE (A) manager of sales, Eastern Division, automotive department, Dahlstrom Metallic Door Co., 305 Bulletin Building, *Philadelphia.*

KEISER, KARL W. (E S) student, University of Minnesota, Minneapolis, (mail) 1148 Churchill Avenue, *St. Paul, Minn.*

KUEN, E. A. (A) vice-president and engineer, Thomas J. Corcoran Lamp Co., *Cincinnati,* (mail) 4900 Spring Grove Avenue.

LEWELLEN, A. R. (M) electrical engineer, Chevrolet Motor Co., *Detroit.*

MINERS, M. VERNE T. (E S) student, University of Illinois, *Urbana, Ill.,* (mail) 107 East Chalmers Street.

MONTANYA, H. L. (A) chief inspector, Yard-O-Meter Corporation, 325 Locust Street, *St. Louis.*

OSMOND, CHARLES H. (A) chemical engineer, Atlantic Refining Co., *Philadelphia,* (mail) 3144 Passyunk Avenue.

PECK, FRANK (A) superintendent, Iowa State Tractor and Automobile School, *Sioux City, Iowa,* (mail) 721 Nebraska Street.

PLEUTHNER, CHARLES (M) passenger-car engineer, Pierce-Arrow Motor Car Co., *Buffalo,* (mail) 51 Norway Park.

PRESBREY, OTIS FLAGG (M) instructor, Polytechnic Institute of Brooklyn, 99 Livingston Street, *Brooklyn, N. Y.*

PRICE, CHARLES S. (M) chief engineer, Bethlehem Spark Plug Co., *Bethlehem, Pa.,* (mail) 1213 Wood Street.

SAMPLE, SAM STEELE (E S) student, University of Illinois, Urbana, Ill., (mail) 404 East Daniel Street, *Champaign, Ill.*

SAWYER, GEORGE W. (A) Sinclair Refining Co., *Omaha, Neb.*

WALKER, GEORGE L. (A) assistant to president, R & V Motor Co., *East Moline, Ill.*

WALTER, CHARLES TAYLOR (J) experimental engineer, Swift & Co., Union Stock Yards, *Chicago.*

WALTON, F. L. (A) general sales manager, Union Switch & Signal Co., Swissvale, Pa., (mail) 802 Ross Avenue, *Wilkinsburg, Pa.*

WHEAT, E. F. (A) superintendent, Y. M. C. A., Ninth and Carr Street, *St. Louis.*

WOODHULL, J. R. (E S) student, University of Cincinnati, *Cincinnati,* (mail) 930 Morris Street.

WYZALEK, JOHN F. (M) metallurgist, Hyatt Roller Bearings division of the General Motors Corporation, Harrison, N. J., (mail) 162 Chestnut Street, *Kearny, N. J.*

ZAHOUR, R. L. (J) student, Case School of Applied Science, *Cleveland,* (mail) 12410 Castlewood Avenue.